MACHINERY
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LOCOMOTIVE REPAIR SHOP PRACTICE

THE CHICAGO & NORTHWESTERN RAILWAY SHOPS AT CHICAGO

ETHAN VIALL*

IN no railroad repair shop in the Middle West is the practice more up-to-date, the amount of work handled greater, or repairs more quickly made, than at the Chicago shops of the Chicago & Northwestern Railway. Altogether there are eighty-one shops in the great cluster of buildings which enclose the thousands of workmen, the clanking machines, the roaring forges and the Gatling-gun-like pneumatic hammers. The average mechanic is apt to look upon a railroad shop as a place where only rough, dirty work is done in an out-of-date manner, but a walk through this works past the huge milling machines, shapers, and high-speed lathes, to say nothing of the drill-presses and boring mills, all of the latest type, would convince anyone that not all or even a larger part of the work is of a rough or dirty class nor done in an antiquated way even if the pieces operated on are as a rule large ones. The milling practice alone of this shop is enough to make the most unobserving "sit up and take notice." Milling cutters with inserted teeth of high-speed steel, plow over rows of castings set in jigs two or three times as long as the ones usually seen on the same class of work. Not only is high-speed steel used in these machines, but also wherever else possible, and beside the big wheel lathes are piles of chips that are not blue but black. The lathe tools are, in many cases, only tipped with high-speed steel, the body of the tool being a cheaper grade of steel to which a small piece of high-speed steel has been welded. This welding is done on the premises and is the first of the kind that I have seen in a railroad shop.

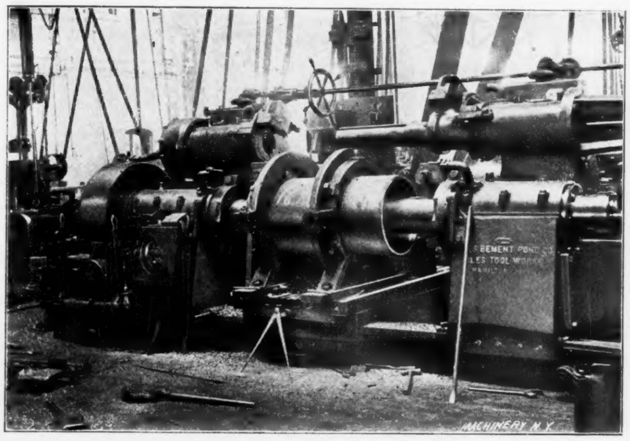


Fig. 1. Boring out a Casting for Piston Rings

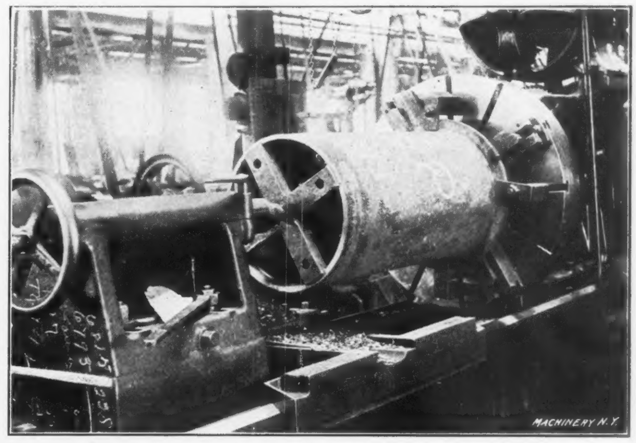


Fig. 2. Turning the Outside of the Piston Ring Casting

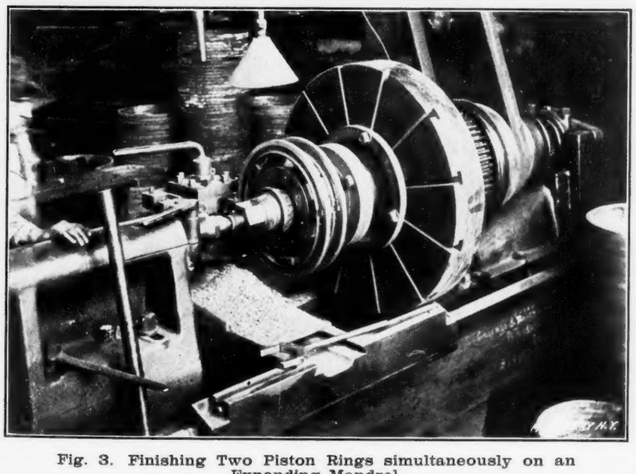


Fig. 3. Finishing Two Piston Rings simultaneously on an Expanding Mandrel

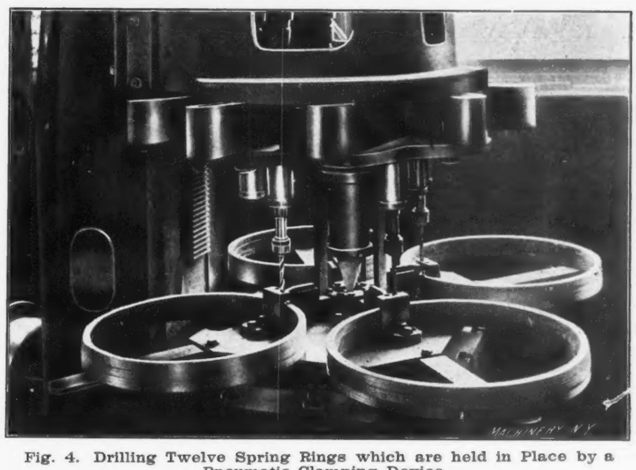


Fig. 4. Drilling Twelve Spring Rings which are held in Place by a Pneumatic Clamping Device

For the handling of materials there are overhead traveling cranes large enough to swing a locomotive, trolley traveling-cranes of the monorail type, swinging cranes, pneumatic hoists, chain hoists and lifting contrivances of every description wherever needed. The power-house is equipped with coal-lifts, automatic stokers, ash-removers and loaders, and everywhere as much manual labor is saved as possible.

While the shop system includes wood-working, painting, car-repairing and numerous other departments that have features of mechanical interest, this article will be confined principally to descriptions of locomotive repair work in its various branches, the machine shop of course coming in for a lion's share of attention. In the beginning I want to express my obligation to Mr. H. D. Kelley, shop demonstrator, who took unusual pains to show me all there was to see and to arrange things for me and assist me in my photographic work. Permission to describe the various methods and processes for the benefit of the readers of MACHINERY, was obtained through Mr. H. T. Bentley, assistant to the Superintendent of Motive Power, Mr. Quayle.

Making Piston Rings

Entering the machine shop from the office one of the first big machines to be noticed is the one shown in Fig. 1, which is at work boring out a piston-ring casting. The way these castings are held while being bored is plainly shown, the jig being very similar to a double steady-rest minus the jaws and in place of which large set-screws are used to center and hold the work. The bored-out castings are taken to the lathe shown in Fig. 2, where they are rough-turned on the

* Associate Editor of MACHINERY.

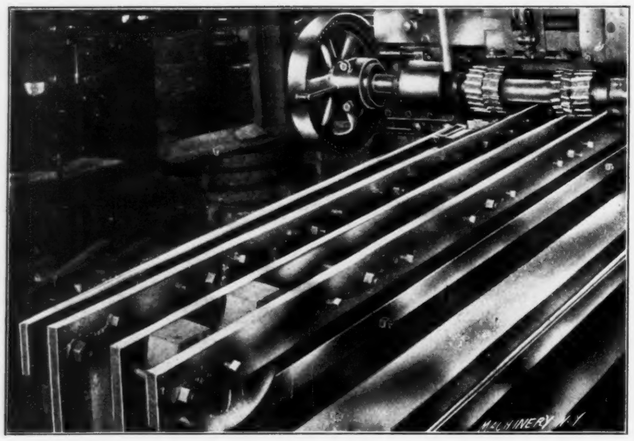


Fig. 5. Fixture for Holding Eccentrics and Eccentric Straps while Milling the Ends

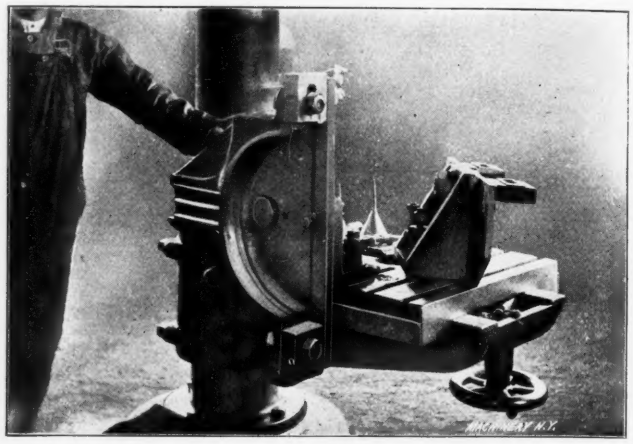


Fig. 6. Indexing Fixture for Holding Eccentric Straps while Drilling Oil and Set-screw Holes

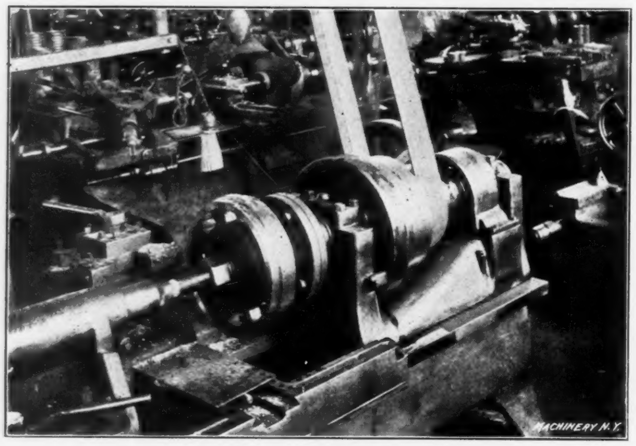


Fig. 7. Turning Eccentric Strap Brasses

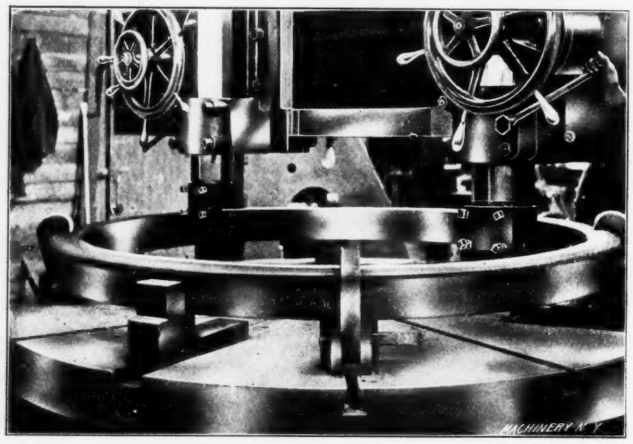


Fig. 8. Driving Wheel Tire held in Place on the Boring Mill by Hook-clamps

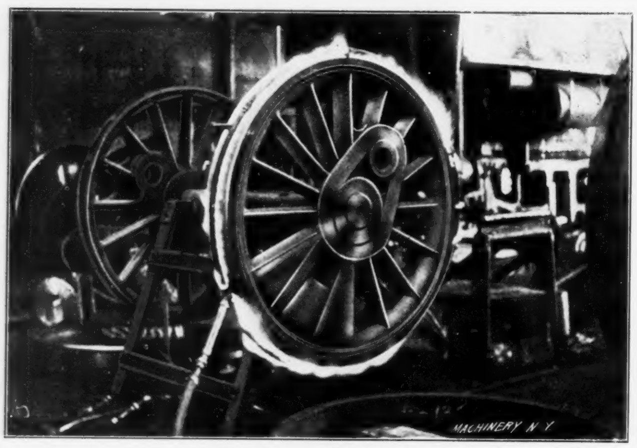


Fig. 9. Gasoline Tire Heater

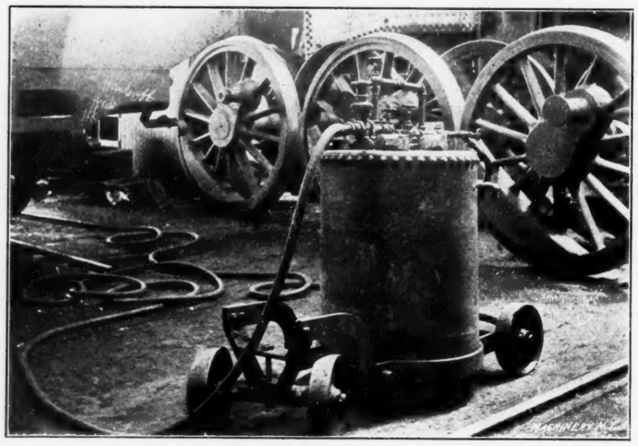


Fig. 10. Portable Gasoline Tank for the Tire Heater.

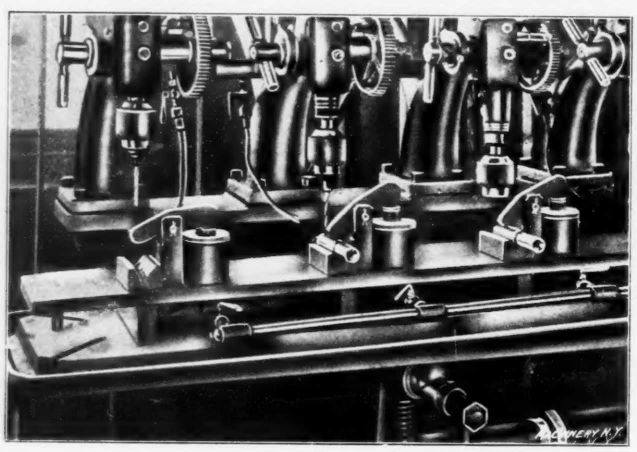


Fig. 11. Multiple Spindle Drill Press with Pneumatic Clamps

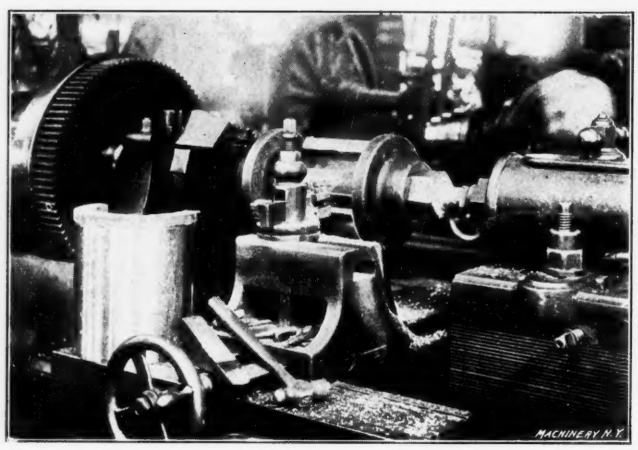


Fig. 12. Mandrel for Holding the Brasses while Turning the Outside

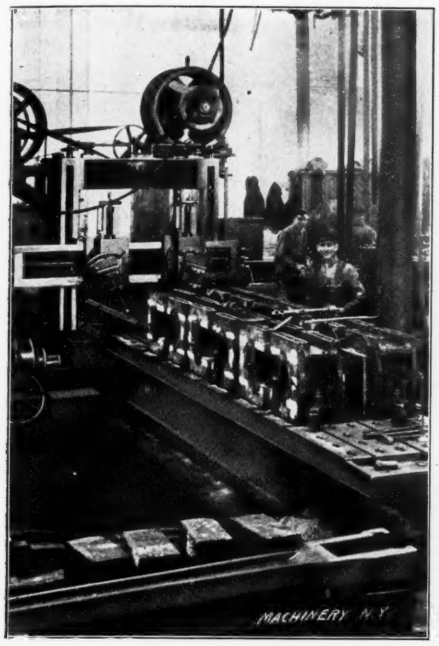


Fig. 13. Planing Twelve Locomotive Driving Boxes simultaneously

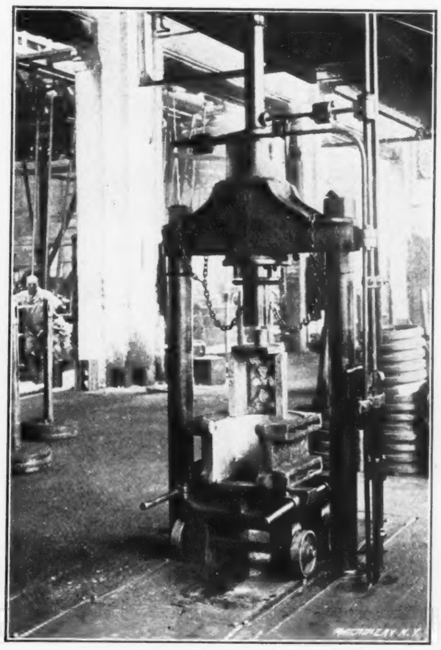


Fig. 14. Hydraulic Press for Forcing the Brasses into Place

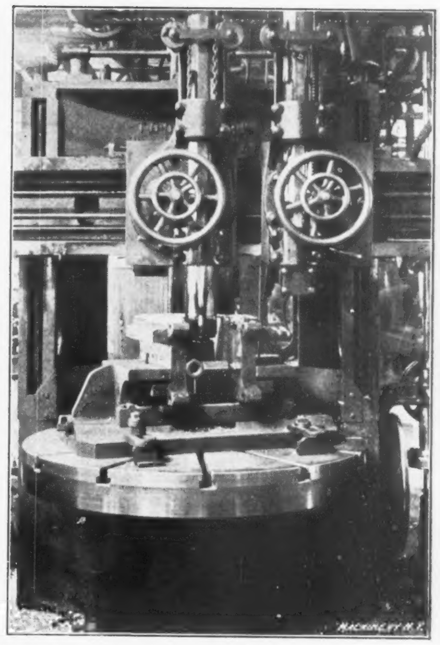


Fig. 15. Boring a Box. Note the Special Two-jawed Chuck for Holding it

outside and cut into rings. In the engraving the undercut chuck-jaws and auxiliary clamps, as well as the spider used on the tail-stock center, can be seen at a glance. In Fig. 3

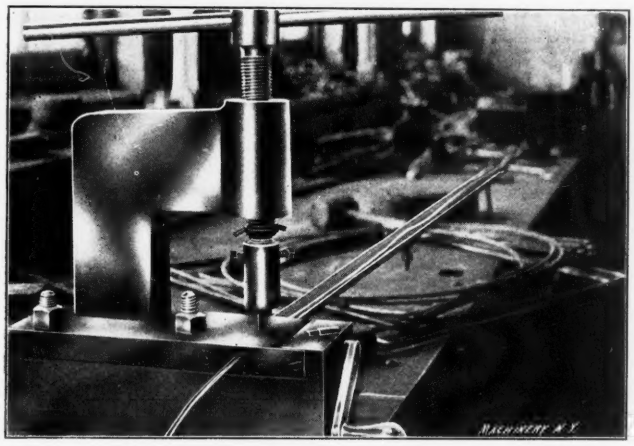


Fig. 16. Press for Cutting Dome and Steam-chest Gasket Wire

is shown the expanding mandrel made to hold two rings which are finished on both sides and to the right diameter, at one cut. The rings are then split and fitted in the usual way.

Machining Driving Boxes and Brasses

Leaving the piston-ring machines, we are next attracted by the way the driving boxes are machined. The first ma-

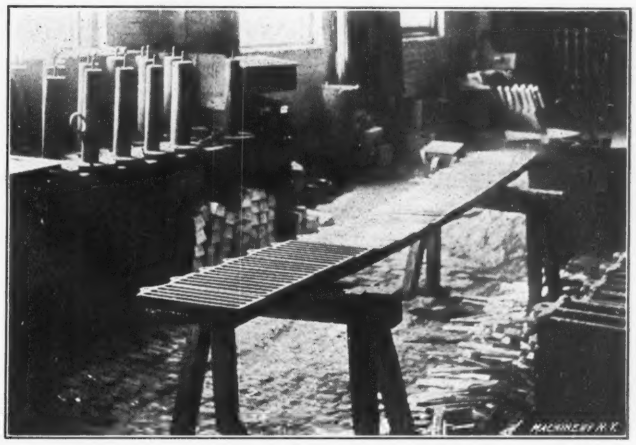


Fig. 17. Solder Molds and Mandrels used when casting Rocker-arm Bearings

chine upon which they are placed is the big planer shown in Fig. 13, which is capable of planing twelve driving boxes at once. Both heads are used, and the jig shown is simply a

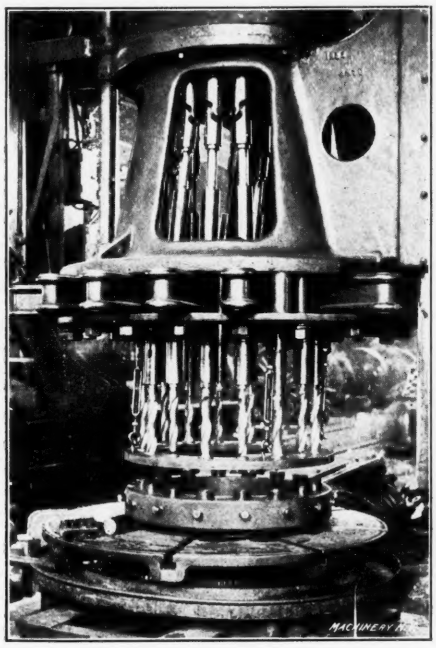


Fig. 18. Drilling Sixteen Bushings simultaneously

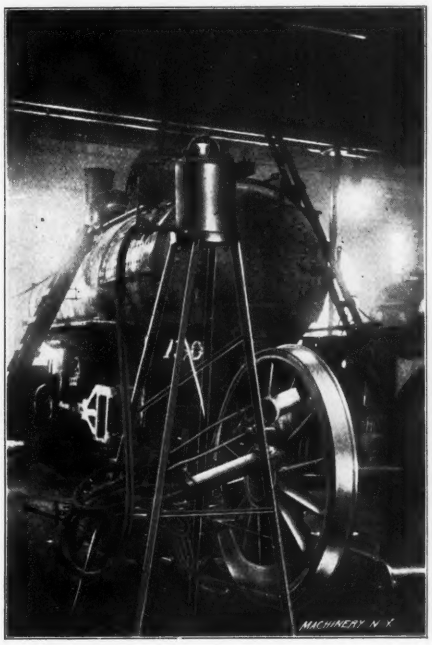


Fig. 19. Crude Oil Burner used for Frame Welding

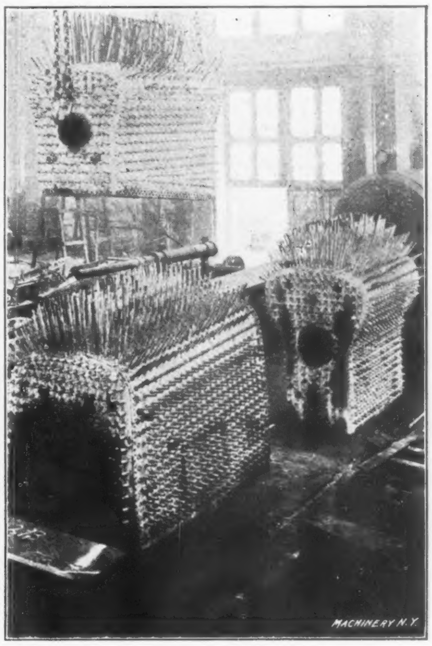


Fig. 20. Fire Boxes removed bodily from the Engine

Fig. 21. Hydraulic Spring-assembling Press

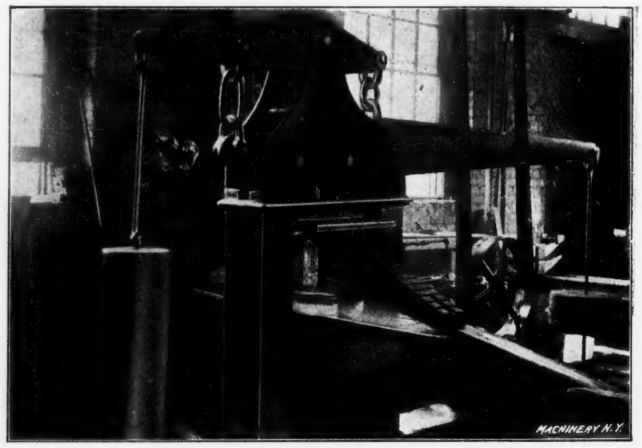


Fig. 22. Tinius Olsen's Spring Testing Machine

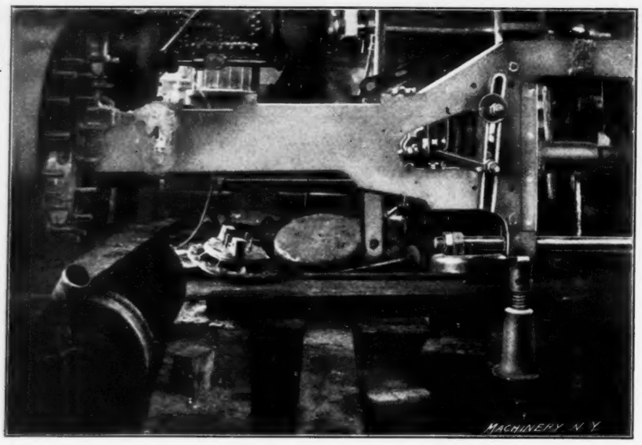


Fig 23. New Section of Frame Welded to the Old by the Thermit Process

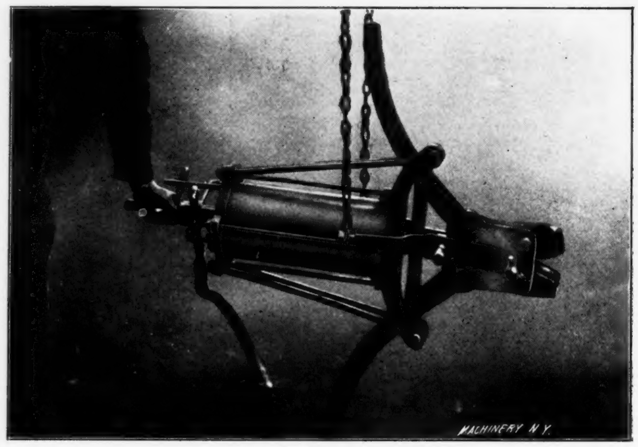


Fig. 24. Pneumatic Staybolt Clipper

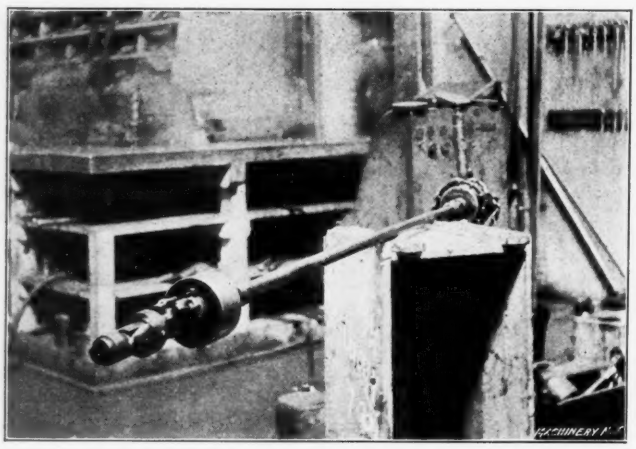


Fig. 25. Pneumatic Flue Cutter which whistles when the Flue is severed

Fig. 26. Pneumatic Flue Trimmer

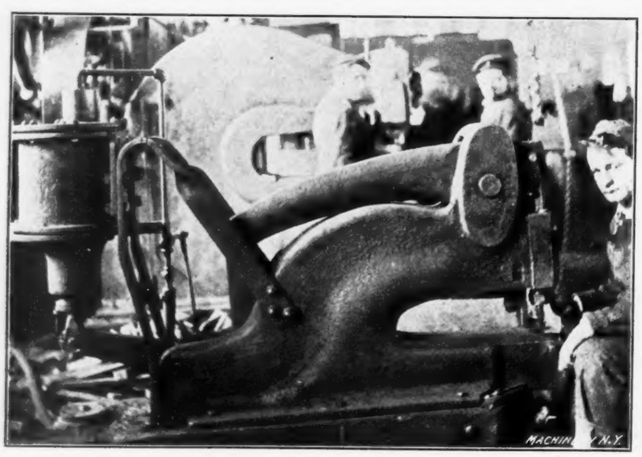


Fig. 27. Old Hand Punch now Operated by Air

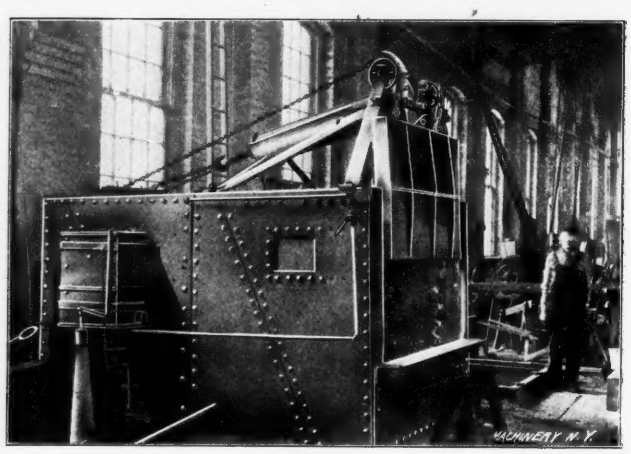


Fig. 28. Case-hardening Furnace with Pneumatic Door Lift

big iron channel (solidly bolted to the table) to which the boxes are clamped by bolts and cross-bars as illustrated. The boxes are then machined for the brasses on the slotter shown in Figs. 41 and 42 on which three are planed simultaneously.

The brasses are pressed into the boxes with a hydraulic press, as shown in Fig. 14. The truck upon which the box is mounted and run under the piston, is a very convenient one as it can be readily lengthened by loosening two locking-collars, and the axles are supported by springs so that under heavy pressure the springs give, allowing the weight to ccme on the heavy legs and not on the axles and wheels. The

Fig. 29. Tool Storage Room equipped with Revolving Racks

way these driving-box brasses are held between two grooved iron flanges mounted on an arbor, while the outside is turned, is shown in Fig. 12, one of the brasses being clamped in place, while a turned one is resting on the lathe carriage.

When the brasses are being bored in the boring mill, Fig. 15, the box is held in a special universal two-jawed chuck which has a stop at the back, against which the partially finished casting is placed. The jaws are then tightened and the box is brought central without any unnecessary loss of time. This chuck is the only one I have seen used for this purpose, as the other shops I have been in simply clamp the work to the platen with bolts and iron straps.

Milling Eccentrics and Eccentric Straps

The ends of the eccentrics and eccentric straps are tongued and grooved on the slab miller shown in Fig. 5. The jig on

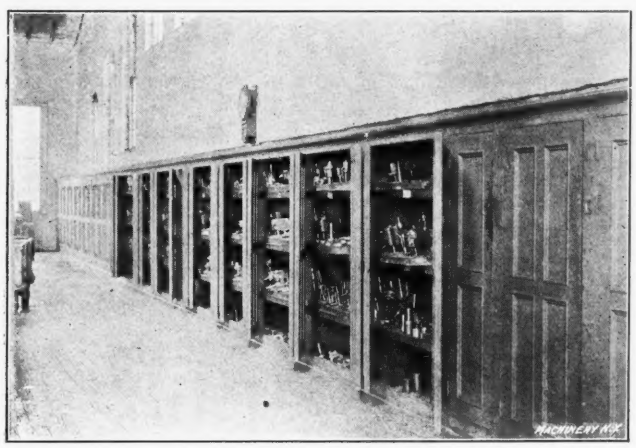


Fig. 31. Row of Tool Cupboards

the machine will hold two different sizes, and sixteen pieces can be placed in it and milled at one setting. Except for its size, the jig is simplicity itself; the work is easily put in cr removed, while if any of the bolts or set-screws break they can be quickly replaced. While drilling the oil and set-screw holes, the eccentric straps are held in an indexing jig, Fig. 6. A similar though smaller jig is shown on the platen. When properly set, these jigs are very handy, for just as soon as one hole is drilled the jig is indexed a notch and the next hole drilled, and so on until finished. An expanding mandrel, Fig. 7, which is of the same general pattern as the one used to hold piston rings, is used to hold eccentric strap brasses while finishing the outside.

Novel Drilling Jig for Link-block Bushings—Drilling Spring Rings, etc.

At the first glance, there is nothing unusual about the appearance of the drill jig shown in Fig. 18, except that it holds sixteen pieces at one time, but a closer inspection shows that the top of the jig holding the drill-guiding bushings, lifts with the drill spindles, allowing the finished work to be taken out by loosening the set-screws. The jig-top is counterbored under each drill-bushing so that as it is lowered it centers itself over the work. The turnbuckles that hold the top and allow it to be adjusted up or down, can be easily seen

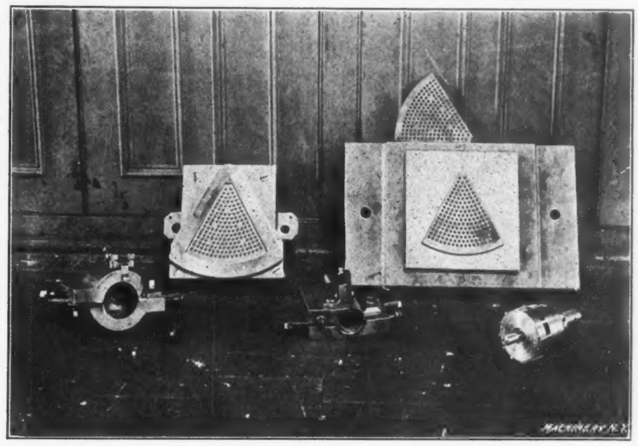


Fig. 30. Box Tools, Expanding Reamer and Strainer Punch and Die

in the engraving. The link-block bushings which are drilled out in this machine, were formerly made of heavy tubing, but now the solid stock is drilled out and the final cost of the bushings is far below that of those made of tubing. Close to this drill-press is another multiple-spindle machine, shown in Fig. 4, which is fitted with a pneumatic chuck for holding and drilling twelve cylinder spring-rings at once. This clamping device is worked by an air-cylinder in the center, the piston rod of which is cone shaped on the end, as shown. As this rod is lowered it forces four short plungers outward, clamping the rings against stop blocks. The ends of the four plungers that come in contact with the rings, are fitted with pins backed by springs to allow for any unevenness or variation in the size of the object clamped. The four-spindle drill press shown in Fig. 11 is used to drill cotter-pin holes in several kinds of bolts and pins. The interesting feature

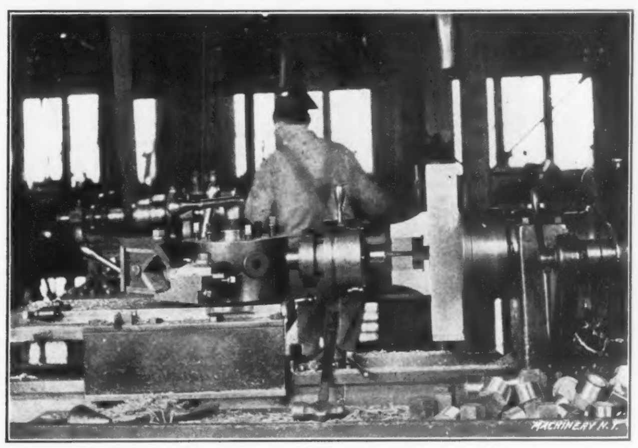


Fig. 32. Lathe equipped for Machining Brass Taper Plugs

of this machine is the pneumatic clamps used for holding the work; nothing more simple or effective could be imagined.

Boring and Removing Locomotive Tires

For holding locomotive tires on the boring mill while turning out the inside, some means other than the regular chuck or face-plate jaws must be used on account of the tendency of the tires to spring out of round because of the pressure from the jaws. This difficulty is overcome by the arrangement shown in Fig. 8. As shown in the engraving, the chucking jaws are only used to center the tire and not to clamp it, the clamping being done by hooks projecting over the top of the tire from the outside, which are tightened down

onto it by the driving in of a taper key. Four of these clamping-hooks are used and they make a very quick and effective method of locking the tires in place without danger of springing them out of round. This scheme has attracted considerable attention and has been copied to some extent in other railroad shops. Using this device on the 96-inch boring

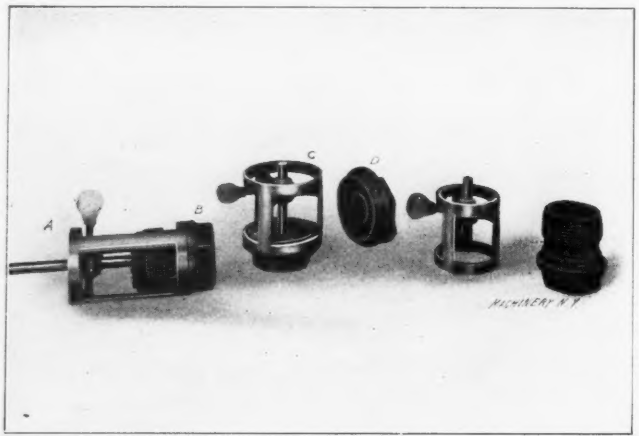


Fig. 33. Gages for Measuring Lift of Air Pump Valves

mill, 54 tires were bored out in 9 hours on a test run, the tires being handled by a pneumatic hoist with an eagle-claw clutch.

To remove locomotive tires, the wheels are hoisted onto a horse by the traveling crane and the tires are heated with the gasoline burner shown in Fig. 9, which quickly heats them so that they expand sufficiently to be easily removed from the wheels. The engraving shows one tire already off and the other being heated. The gasoline vapor used in this heater is obtained from the portable tank, Fig. 10, the pres-

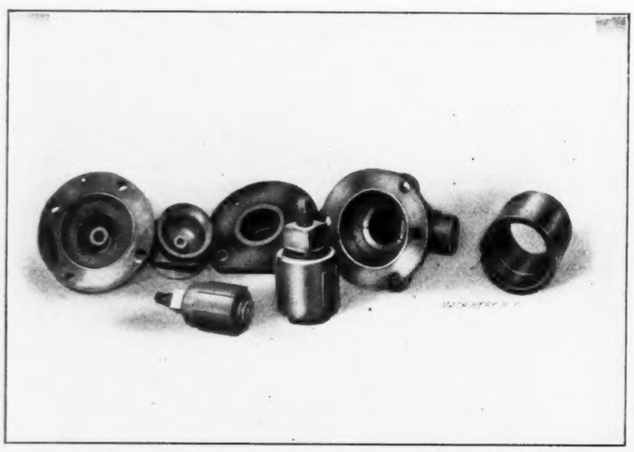


Fig. 34. Types of Reamers used for Air Pump Repairing, and Examples of the Work

sure being supplied by air through a hose connected to the shop pipe line. This tank is very handy and is used to supply several other kinds of burners beside the one shown.

Fig. 19 is a crude oil burner, stand and tank, used on some jobs of frame-welding, though the Thermit process is used for most of them. A Thermit repair is shown in Fig. 23, and aside from the method of welding, the job is interesting from the fact that a section of the old frame has been cut out and a new one is being put in. At *A* the end of the section has been welded onto the old frame and is ready to chip, while at *B* the wax core for the next weld is being made. The reason that a new section was put in is that the old frame showed so many defects at this place that it was not thought advisable to risk any repairs on it; so the bad section was cut out and a new one put in as shown. A frame repaired in this way is just as good as an entire new side and far cheaper, as only a few bolts, rivets, and braces have to be removed in comparison with the number connected to the whole side. In the opinion of the foreman in charge the cost of the work on this particular job would not exceed fifty dollars; whether or not this was more than a mere guess, I'll let those familiar with the work decide.

Interesting Tools and Methods in the Boiler Shop

There are very few shops capable of removing fireboxes with radial stay-bolts bodily, as shown in Fig. 20, but this is an everyday occurrence here, and is one of the sights of the shops for visitors. Mr. J. W. Kelley, the foreman of the boiler repair department, is justly proud of his work.

A patented pneumatic stay-bolt clipper, Fig. 24, is used for removing bolt heads on most of the boiler work in this department, and another patented pneumatic device, Fig. 25, is used for cutting out old flues. This tool differs from some similar ones in having a roller cutter (like the one on the familiar hand pipe-cutter) instead of a single blade, and also in having a shrill alarm-whistle which sounds the instant the flue is cut off, thus preventing waste of time whether from carelessness or intention. The shriek of the whistle is ear-splitting and can be heard for half a block above the usual din of the boiler shop.

All old flues are rattled or tumbled in a huge tumbler full of water, and from appearances this seems to be a more

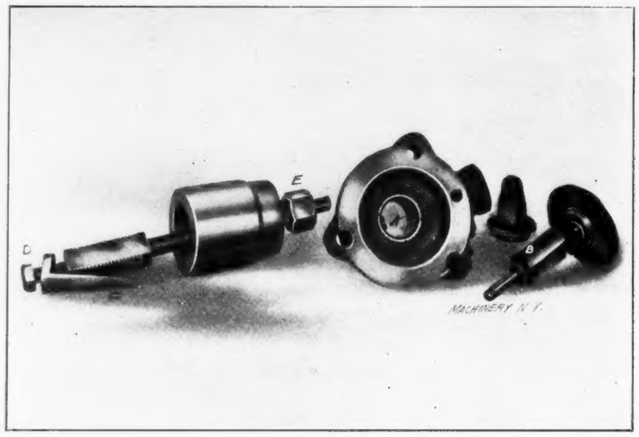


Fig. 35. Triple Valve and Tool for Facing Seat

effective way than the dry method practiced in some shops, though the results are good either way. The number of flues that are welded here will range from five to nine thousand a month, and one of the best machines for trimming flues to length that I have seen, is shown in Fig. 26. This machine is the usual form of rotary cutting machine to which has been added an air-cylinder for raising and lowering the cutter. In all of those that I have seen elsewhere this is done by means of a hand-wheel, but for ease and speed the air device is much superior to the hand method. The use of an air attachment on the flue cutter brings me around to the old hand-power punch, which has been made over by the addition shown in

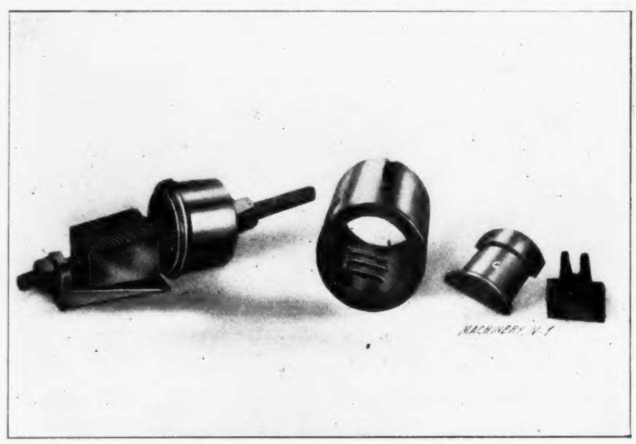


Fig. 36. Main Valve Bushing with Tool and Guide for Facing Valve Seat

Fig. 27. In this way a tool that was practically useless for doing a large amount of work, has been made into a productive machine.

Assembling Locomotive Springs

In the blacksmith shop, which is in charge of Mr. John McNally, the new springs used for repair work on all classes of locomotives, are cut, rolled, tempered, assembled, and tested, or new leaves are put in to replace broken ones in old

springs. Fig. 21 shows the special hydraulic press used to clamp the leaves together while a temporary ring is slipped on to hold them while putting on the regular band. After the temporary ring is in place, the spring is removed from the press and set on end in a socket, as shown in Fig. 45. The hot band is then dropped over and driven to place by means of a hand-set and sledge-hammer. As soon as the band is in place, the spring is put in the 100-ton hydraulic press, Fig. 46, which compresses the band around the spring in a box-like die and holds it firmly until it cools and sets. After cooling, the spring is next tested in the big Tinius Olsen testing machine, Fig. 22. The spring shown in the engravings is known as a trailer spring for class D engines, and is tested to 21,560 pounds, while the maximum load it is expected to carry is rated at 17,250 pounds.

The case-hardening furnace used in the blacksmith shop has a pneumatic door-lifter, that saves lots of time and trouble, which is shown in Fig. 28. The arrangement is very simple and could be used to good advantage on almost any large furnace of this type where connection with the air line can be easily had.

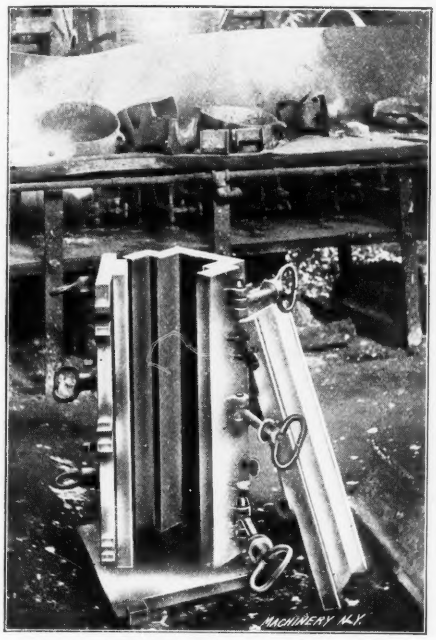


Fig. 37. Mold for Babbitting Two-bar Guide Cross-head Gibs

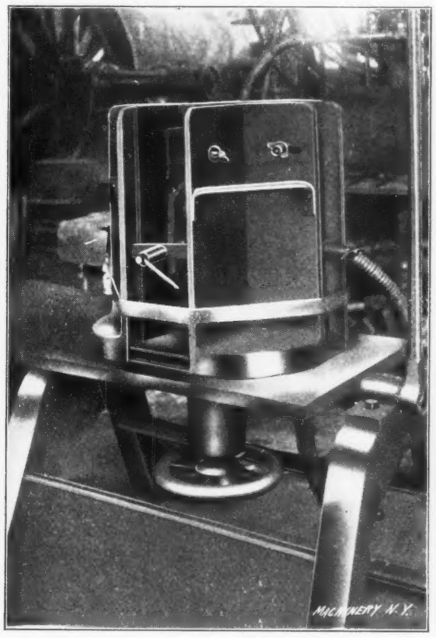


Fig. 38. Mold ready for Babbitting a Four-bar Guide Cross-head

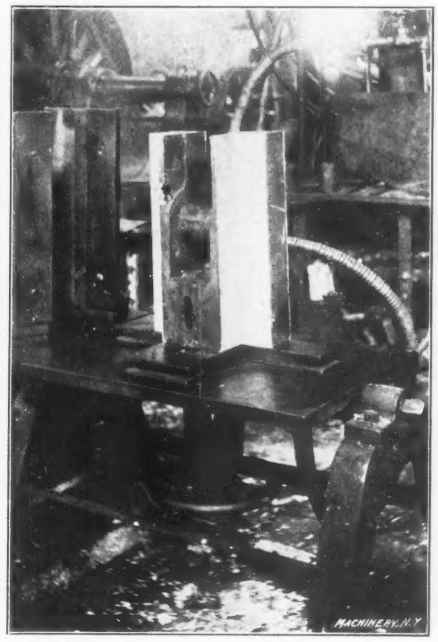


Fig. 39. Cross-head Babbitted in the Mold shown in Fig. 38

Fig. 40. Heating the Cross-head Prior to Pouring the Babbitt

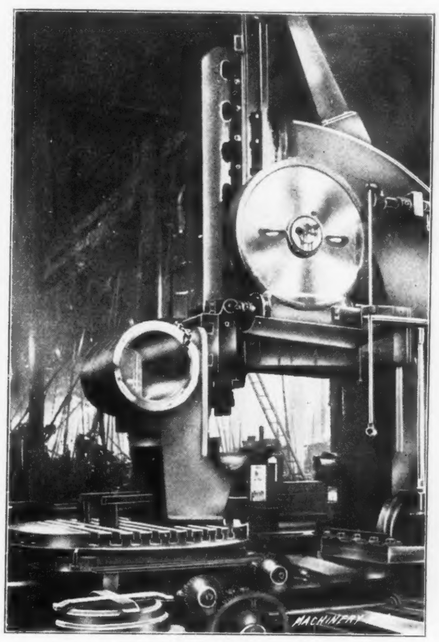


Fig. 41. Machining a Cylinder on a Slotter—First Position

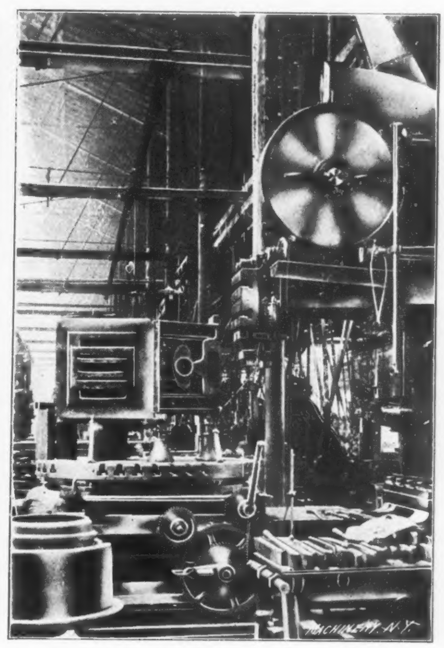


Fig. 42. Machining a Cylinder on a Slotter—Second Position

Tool Storage, Brass Finishing Department, and the Brass Foundry

The tool-storage room of the main shop is well equipped in every way, the revolving racks, Fig. 29, being especially neat and convenient. Close to the toolroom, which is in charge of Barney Henrickscn, is the brass-finishing department in charge of William Wafer. The box-tools in use in this department are the equal of those used in the finest brass-working shops in the country. Two of the wing-type box-tools are shown in Fig. 30, and a special expanding reaming tool is shown at the right, while leaning against the wall is a strainer punch and die of splendid workmanship. The tool cupboards, a few of which are shown open in Fig. 31, are filled with box-tools, forming tools, special taps, dies and the like, which are all made in a way that would reflect credit on any toolroom.

Fig. 32 shows a lathe set up for machining brass taper plugs. The box-tool used is shown swung around, while the self-opening die is just ready to begin to cut the thread on the taper plug held in the two-jawed chuck.

The brass foundry, in charge of Mr. T. Ryan, has two kinds of brass milling furnaces. One is a regular crucible furnace which is used for the finer grade of brass castings, while the other kind is of the box-type, crude-oil-fired furnace shown in Fig. 49. These furnaces are so made that they can be easily tilted by means of a hand-wheel, and in this way all melted brass is easily run out or kept in, as desired. A very refractory black slag forms on top of the brass melted in this way and has to be carefully skimmed off to prevent it mixing in and spoiling the castings.

Fig. 43. Babbitting Car Brasses

Fig. 44. Furnace for Melting Babbitt from Old Brasses

A machine that is said to save at least twenty-five dollars a day for the brass foundry is shown in Fig. 48. It is a washer used to wash out all the dirt and save the brass chips and lumps that would otherwise be lost. A pile of several hundred pounds of brass, representing three days washing, showed what a gold mine was being successfully worked.

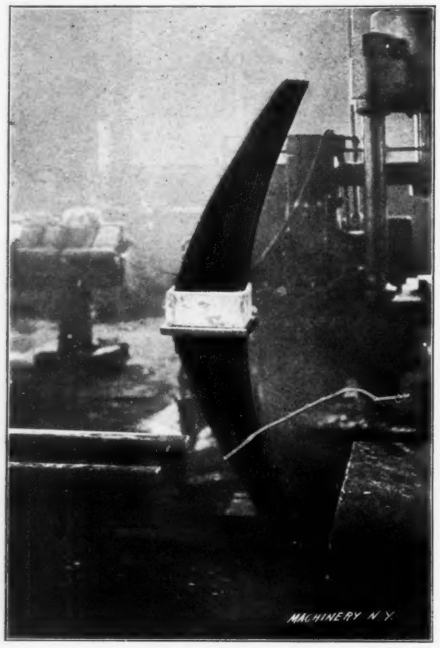


Fig. 45. Position of the Spring as the Heated Band is Put in Place

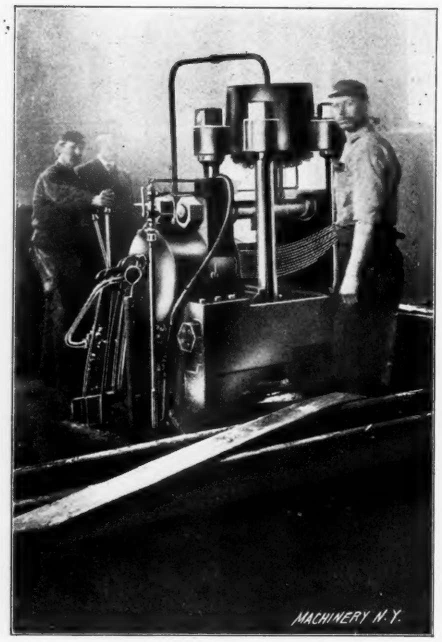


Fig. 46. Hydraulic Press which compresses the Band on the Spring while it cools

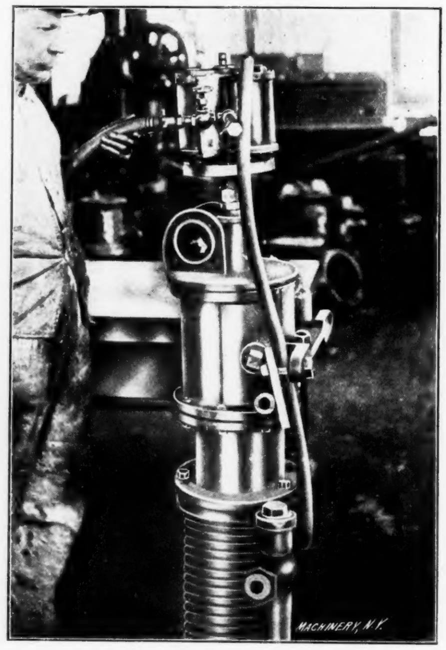


Fig. 47. Grinding an Air Pump Head with Air Motor

Air Pump Tools and Gages

There are many ways of obtaining the proper length of plug for the right valve lift in an air-pump, but I have seen nothing better than the gages shown in Fig. 33. The gage *A* is used when fitting the longer plug or cage *B* for the lower air valves (see also Fig. 50) while the shorter gage *C* is for the upper cap *D*. Each gage consists of a brass barrel through the middle of which slides a short rod, which is locked at any point by a thumb-screw. This rod is as much longer than the brass barrel, as the lift of the valve is to be. When fitting the upper plug *D*, the barrel of the gage *C* is set over the plug opening in the pump and the rod is pushed down until it comes into contact with the top of the valve. The thumb-screw is then tightened and the plug is so dressed that when it is inserted in the opposite end of the brass barrel, as shown at *C*, the boss against which the valve strikes, just touches the end of the iron rod. When fitting the lower

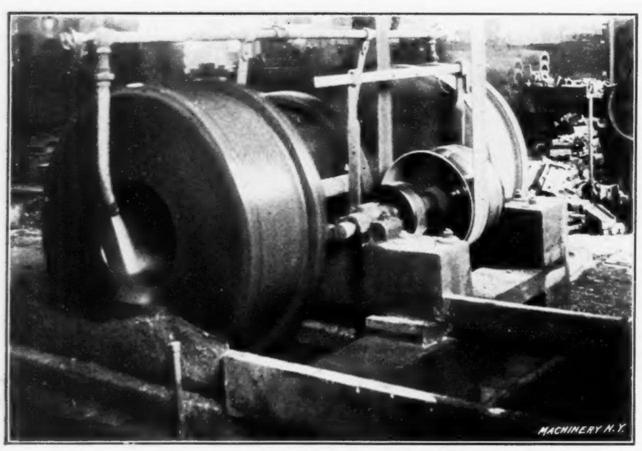


Fig. 48. Washing Machine for Separating Fine Particles of Brass from Foundry and Shop Dirt and Cinders

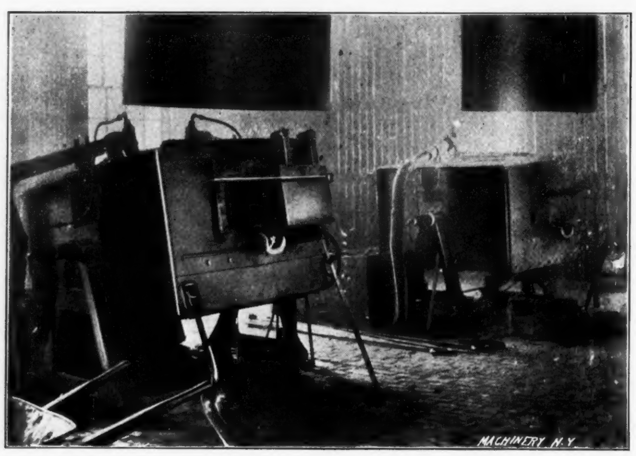


Fig. 49. Box Type of Brass Melting Furnace, which is fired by Crude Oil

plug the gage *A* is placed over the valve opening as before, and the rod is set against the boss *b* (Fig. 50), against which the lower valve strikes. The plug and valve are then dressed until the latter just touches the opposite end of the gage rod when tested as shown to the left in Fig. 33. Gages for the various valves are kept on hand and there is no excuse for a mistake in getting the right valve lift.

For facing off worn cylinders of triple or brake valves, pump governors, main valve bushings, and cups for air pump heads, the class of expanding reamer shown in Fig. 34 is used. The reamer blades are forced outward by means of the small screw in the middle of the wrench-hold. The tool used for facing off the worn seat of the triple valve at *A*, Fig. 35, to which the part *B* fits, is something on the plan of a broach. It is set to cut the right amount by means of the wedge *C* and cap-screw *D* and it is drawn through the cut by screwing the nut *E* down on the spindle, which is kept from turning by a box-wrench on the squared end. A similar tool used for facing the seat of the main valve bushing for the 9½-inch air-pump, is shown in Fig. 36. This tool differs from the one just described, in that it has a back *C* to slide on while it is cutting. This cutter hasn't the tendency to turn that the one illustrated in Fig. 35 has, on account of the flat cutting surface, so no wrench is needed to keep the drawing spindle from rotating when the nut is being turned.

Fig. 47 shows how the top-head of a 9½-inch air-pump is ground to a perfect fit, with an air motor to turn it, while emery is used as a grinding medium.

Babbitting Jigs

The jig used while babbitting the crosshead slippers for alligator guides, is shown in Fig. 37, while Fig. 38 shows the jig used when babbitting crossheads for four-bar guides, with a crosshead in place, the side-plates on and all ready for pouring. Fig. 39 shows the crosshead finished and the jig with the side-plates removed. The way the crossheads are heated before they are placed in the jig is shown in Fig. 40.

Car-brasses are babbitted by placing them face down on the special half-mandrels shown in Fig. 43, and the babbitt is poured in through the holes in the brasses. Thousands of these brasses, just as they came from the cars, are shown in the pile in the background. These old brasses are thrown into the furnace, Fig. 44, and heated just enough to melt the babbitt, which runs from a spout into the big kettle shown at the right of the furnace. If the brasses are not too much worn they are re-babbitted, but if they are badly worn they are melted up and re-cast.

Miscellaneous Features of Interest

In Figs. 41 and 42 is shown an unusual way of machining engine cylinders on the slotter. Many advantages are claimed for this method, however, such as quickness and ease in handling and setting, and steadiness under a cut.

All sheet rubber or sheet copper gaskets used for any purpose in these shops are cut in special punch-press dies. The initial cost of the punches and dies is, of course, large, but the aggregate time saved for a year's repair work is enormous. Some cover and steam-chest gaskets are made of heavy copper wire, which is cut to the right length, after which the ends are square-lapped and brazed. The cutting and square-lapping is done at one stroke on the hand-press shown in Fig. 16. An adjustable stop on the bench, in line with the cutting-die, and graduations on the bench for the different sizes of gaskets used, makes it but the work of a moment to cut any size gasket wanted.

As solder is used in immense quantities in the various departments, it is mixed and cast into sticks in the works, the molds being shown in Fig. 17. The nearest molds have been emptied while the white appearance of the rest is caused by the steam of the water used to cool the solder. Close to the window is a set of mandrels for use in casting rocker-arm bearings. These mandrels vary in size by thirty-seconds of an inch, so that a mandrel can be selected from the set that will, by allowing for shrinkage, enable the molder to cast a bearing to fit any rocker-arm that can be used.

Beside their splendid shop practice, these shops have one of the best apprenticeship systems that I have found anywhere, which will be described in detail in another article.

BORING-BARS AND HEADS*

LUCIEN L. HAAS†

The design of a boring-bar or head is usually somewhat of a problem to most designers, as so much is often required of these tools. There are many important things to be considered in connection with this work, and in the following description of twenty different designs, which are illustrated in the Data Sheet accompanying this issue, I shall endeavor to cover at least the greater part of the questions involved under this head.

Fig. 1 illustrates a temporary boring-bar, which is an old design that is used universally. The end of the bar has a

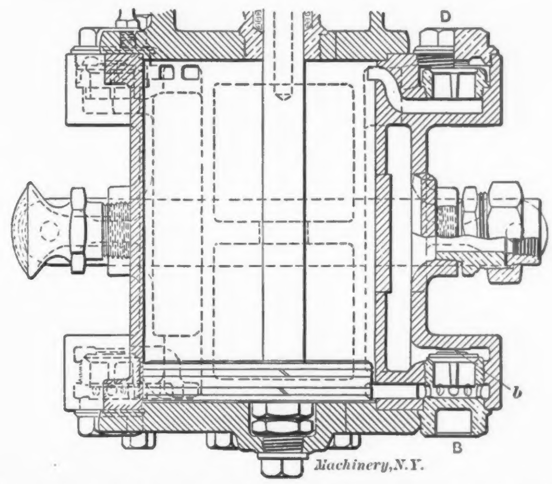


Fig. 50. Section of Air Cylinder of 9 1-2 inch Westinghouse Pump—The Valves are given the Correct Lift by the use of the Gages shown in Fig. 33

square slot through it into which the square tool *A* is a sliding fit. The tool is clamped in place by the set-screw *B* (which should be of the standard size), and is adjusted by tapping it lightly with a hammer. The bar shown in Fig. 2 is very similar to that of Fig. 1 with the exception that the tool is round instead of square. Set-screw *C* also provides means for a finer adjustment of the cutter than could be obtained for the one shown in Fig. 1. The set-screw *B* which bears against a flattened side on the cutter, clamps the latter in place. If this flattened surface is not provided on the tool it is liable to turn when taking a cut and serious damage may be the result. The bar illustrated in Fig. 3 is so designed that the cutting edge of the tool *A* is slightly in advance of the end of the bar. This tool is held by the screw *B* and adjusted by the screw *C*. Of course, it is necessary to remove the tool when making adjustments. This bar is adapted to boring blind holes, or for working close to shoulders, etc. The cutting tool should be set at an angle of about 60 degrees with the axis of the bar. Fig. 4 is a design of boring-head with two cutting tools. This head, after it has been hardened, is ground on the exterior *D* so that it can be used to guide the tools. It is fastened to the bar by the threaded shank shown. The cutting tools, which are set at an angle of 45 degrees, are made of round stock, and are held in place by set-screws *B*. When the tools are to be adjusted, they are removed and the adjustments are made by the screws *C*. Fig. 5 illustrates a bar with a cutter which is adjusted by means of a nut *C*. The tool is only threaded at one end and is a sliding fit in the bar. When properly adjusted it is held by the set-screw *B* which bears against a flattened surface. That part of the bar which is in contact with the nut *C* is also flattened. While all boring-bars will work with good results for a short time with soft centers, it is always advisable when accurate work is to be done to insert hardened centers *D* in the ends of the bar. These are easily made, and often much time has been wasted and much work lost simply because this point has been overlooked.

The types shown in Figs. 6 and 7 are very much alike with the exception that the cutting tools are held differently. With the design of Fig. 6 the cutter can be placed in the

* With Data Sheet Supplement.

† Address: 341 Landon St., Buffalo, N. Y.

center of the boring-bar as well as at the end; but with the method of fastening shown in Fig. 7, the tool must be located at the end. In one case, as will be seen by referring to the illustrations, the cutter is held in place by a wedge, while a set-screw is used in the other. The tools in both cases should be made to hook over flats on the bars, thus centering them. The cutting edges are backed off similar to the teeth of a milling cutter. Both these designs are very good for heavy boring or cutting. Two designs which are also very similar are shown in Figs. 8 and 9. As will be seen, the ends of the bars are slotted, and the tools fit into these slots centered by fittings on either side, as in Figs. 6 and 7. Bars of this type are designed to face as well as bore, and they are admirably adapted to roughing out heavy work. The cutter in Fig. 8 is held in place by the conical-pointed screw which bears against a slot milled to an angle of 30 degrees in the cutter. As *C* is screwed inward the cutter is forced against the bottom of its slot. The cutting tool in Fig. 9 is held by means of a hardened bushing *D*—the flattened side of which is forced against the cutter by the screw *B*—which, as shown, is placed at an angle of 6 degrees with the side of the cutter. This method of fastening the tools is more expensive than that shown in Fig. 8, and does not give any better results. Fig. 10 shows a single-step tool with means of adjustment, which I have used in automatic turret machines for boring out steel, with excellent results. It has been found advisable, through experience, to equip a bar carrying such a tool with a pilot as shown in the illustration. The bar can be made of ordinary machine steel, but the pilot should be carbonized and ground to fit whatever sized bushing is used in the head of the machine. The cutting tool is beveled on the bottom at an angle of 30 degrees, and is adjusted by means of a hardened headless screw *C*, which has a corresponding taper. The tool is held in place by the two screws *B*.

The bars shown in Figs. 11 and 12 were designed for light boring, in such metals as aluminum, etc., and give the very best results for this class of work. Slots are cut on either side of the bar into which the cutters *A* are fitted. Hardened bushings *D* and screws *B* hold the cutters as in Fig. 9. The design illustrated in Fig. 13 works very successfully where there is facing as well as boring required, when it is absolutely necessary to have the cutters adjustable, and, as often happens, when it is also necessary that the cutters be held in place by some simple means accessible at the back instead of at the face or side of the head. The bar is slotted across the end to receive the two tools which are also slotted, as shown at *D*, sufficiently to allow one side of the round heads of the clamping bolts *B* to enter. This arrangement makes it possible to clamp the cutters by simply tightening the nuts on the bolts *B*. The tools are adjusted by the conical-pointed screw *C*, the end of which bears against the inner ends of the cutters, which are also tapered. The design shown in Fig. 14 is excellent when a boring-head for finishing cuts is wanted. It acts similarly to a reamer, and the tools *A* are very easily adjusted as they fit in tapering slots, and adjustments are obtained by varying their position. The clamps *D* and the screws *B* hold them in place. The bar shown in Fig. 15 is one that has been used for years as a roughing tool for cast iron cylinders.. The small cutting tools *A* which are held in place by the screws *B*, fit tightly in the slots provided for them. This design is defective, however, in that when adjustment is required it is necessary to insert new cutting tools.

Fig. 16 illustrates a design which is preferable to the one shown in Fig. 15, as the tools are provided with adjustment and, in addition, are rigidly held so that they will withstand a great strain. The bar is especially adapted to the boring of cast iron cylinders and gives excellent results when made up in sets for roughing and finishing. The bar has a slot across the end in which the boring cutters *A* fit. These cutters are notched, as shown, to allow the partial entrance of the heads on screws *C* which give the necessary adjustment. When the cutters are set they are held in place by the hardened set-screws *B*. The inserted-tool boring head shown in Fig. 17, is one of the strongest made. It is intended for boring steel, and will stand up under the most severe tests. The head should be made of steel and the cutting tools, should be made of the very best high-speed square steel and a sliding fit in their slots. The end of the head should be bored out first for the ring *D* and then slotted for the cutters and tapped for the set-screws *B*. Ring *D*, which contains the adjusting screws *C*, may then be driven in place. Fig. 18 illustrates a boring-bar or head with two inserted blades, which is an excellent tool for finishing brass or aluminum and may also be used for steel as well. The head is attached to the bar by means of a threaded shank. The cutting tools are tapered on the bottom and fit in slots having a corresponding taper, thus providing means of adjustment. They are clamped in place by driving in the taper pins *B*. Fig. 19 shows another design of boring-bar head, for finishing, which is attached to the bar in the same manner as the one shown in Fig. 18. The blades are also held in practically the same manner, but instead of using taper pins which often work loose, specially designed hardened screws *B* with heads tapered to about 8 degrees included angle, are used to clamp the cutters. Fig. 20 illustrates an excellent design for small cylindrical boring. The bar is threaded to fit the hardened collar *D* and the lock-nut *C*. The ring *B* should be a sliding fit on the bar and is kept from turning by the key *E*. This ring is slotted to suit the cutting tools, which should be made of square stock and which are adjusted by screwing back the collar *D* and tightening the lock-nut *C*. Three cutting tools are shown, but this number can be varied according to the size of the head.

* * *

GREAT POSSIBLE INCREASE OF BOILER CAPACITY

A preliminary report on the work of the Technologic Branch, United States Geological Survey, relating to experiments on steam boilers, has recently been issued. These experiments have been undertaken to ascertain the possibilities of increasing the capacity of boiler plants. It is stated in the report that the experiments so far made indicate that it is possible to double or triple the capacity of the plant without making any radical changes in furnace and boilers. This increase would require that a correspondingly increased amount of air be put through the grates; to do this, it would be necessary to apply increased pressure to the air, in order to force it through the grates. An equipment of fans designed to supply three or four times as much air under several times the pressure would be required. The results, however, appear as yet to be only tentative. The forcing of air under high pressure through the grates would require considerable power, and the proper ratio between this increased power, and the increased efficiency, must be established. It should not be attempted to force more air through existing grates by running fans a great deal faster, because the power required for this increases in too rapid a ratio. New fans would have to be installed of sufficiently larger size to supply the larger quantities of air at higher pressure. It is likely that new designs of grates, stokers, furnaces and boilers would be required in order to obtain the highest efficiency; but while the designs be improved, it is understood that no radical changes would be necessary. The United States Geological Survey will, in the near future, issue a bulletin on "The Significance of Drafts in Steam Boiler Practice" and another bulletin entitled "Drafts." They will deal in detail with the question of the influence of increased draft on the capacity of steam boilers.

* * *

An army officer whose duties require him to frequently visit three large cities which are so situated that a straight line drawn from one to the other forms a perfect triangle is soon to be court-martialed for adding a fourth side to the triangle.—*New York Times.*

This description of an equilateral triangle as a "perfect triangle" is on par with a "round circle." The addition of a fourth side would stagger Euclid himself. A caustic contemporary remarks: "That unique triangle ought to be put in a museum and kept there for the everlasting delectation of mathematical amateurs."

VERTICAL SAW-TOOTH ROOF CONSTRUCTION

In the accompanying illustrations is shown a type of vertical-sash saw-tooth for roof lighting, developed by F. W. Dean, mill engineer and architect, Boston, Mass. It, of course, is commonly known that in order to exclude direct sunlight from a skylight which faces toward the north the angle of inclination of the sash varies with the latitude. In general practice the face is inclined at an angle of between 60 and 80 degrees with the horizontal. The angle of 60 degrees which has been adopted by some as a standard in the average latitude of the principal manufacturing industries in the United States admits some direct rays when the sun is in the zenith. For the mean latitude of the United States it may be shown that the angle of the face should approximate 73 or 74 degrees.

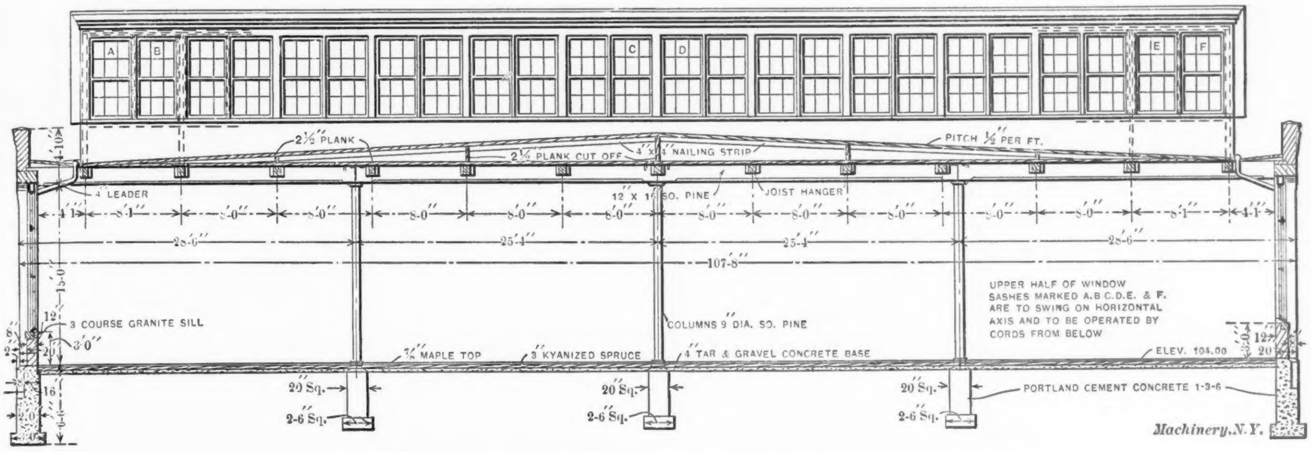


Fig. 1. Section through Building having Vertical Saw-tooth Roof

Study of the angles concerned shows that it makes but little difference in the lighting whether the face be vertical or not, but it is manifest that in features of construction and maintenance the vertical face avoids certain somewhat objectionable features of the inclined surface. Not only is the roof of the skylight more easily and simply supported in this design, but ordinary window sash may be used in place of the somewhat elaborate form of rigid metal sash with special provisions against leakage which is required when the glass is inclined.

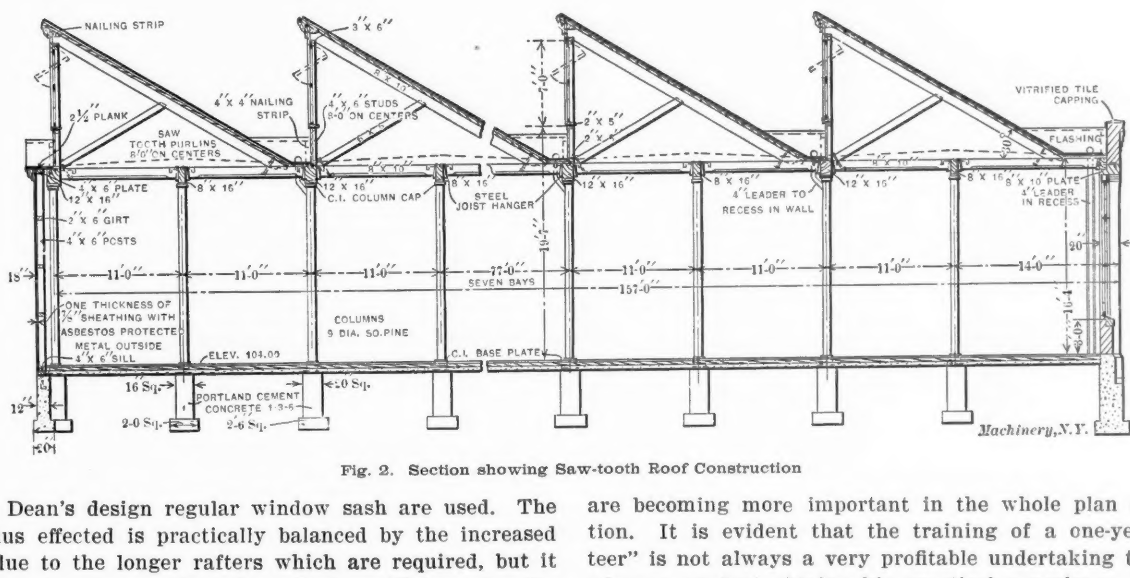


Fig. 2. Section showing Saw-tooth Roof Construction

In Mr. Dean's design regular window sash are used. The saving thus effected is practically balanced by the increased expense due to the longer rafters which are required, but it is not necessary to provide independent ventilators, for the upper sash are hung on a horizontal central axis and arranged to be operated by cord from below. By this arrangement the ventilation can be regulated to suit the exact requirements, either by opening some of the windows, or opening all a portion of the way. Condensation on the glass is positively caught by the zinc trays at the stools. The skylight roof, which is inclined at an angle of 30 degrees to the horizontal, consists of 2½-inch plank carried on 8 by 10-inch rafters, spaced 8 feet on centers and braced by 6 and 6-inch struts. The roof is covered with plastic slate, which is extended up the front of the skylights to act as flashing. The skylight windows are about 3½ feet wide by 6½ feet high.

This style of roof was used on the machine shop recently designed by Mr. Dean for the Canadian Rand Co., Ltd., of Sherbrooke, P. Q. It has also been employed to advantage in textile and similar mills.

* * *

TRAINING OF GERMAN ENGINEERS

An interesting reference to German methods in the practical training of engineers is given by Mr. Franz zur Nedden in the *Engineering Magazine* for April, 1909. The practical training of a German engineer is briefly as follows: The boys usually leave the high-school at an age of eighteen years. All German technical colleges require that candidates for admission must have passed through a year of practical work in a machine shop or factory. During this year the students are called volunteers and not apprentices, the name indicating that their aims are different from those of the latter class This year of practical work is followed by four years of study in the technical college. Each year there is a three months' vacation, during which additional practical training is acquired. There are no shops for special training in the colleges, although from year to year the mechanical laboratories are becoming more important in the whole plan of instruction. It is evident that the training of a one-year "volunteer" is not always a very profitable undertaking to the firm where a student obtains his practical experience, and therefore a number of prominent German machine firms require a payment by the student of from $75 to $125 a year for giving special training to prospective engineers. Some firms, among which may be mentioned the Ludwig Loewe & Co., have instituted a high-grade educational course for their regular apprentices which was mentioned in the September, 1908, issue of MACHINERY, and their volunteers attend this course also.

FORMULAS FOR CRANE BEAMS OR GIRDERS

C. R. WHITTIER*

In a former article (March, 1909) it has been shown that for I-beams of the minimum sections, which are commonly used, with a fiber stress not exceeding 16,000 pounds per square inch, and properly braced sideways at distances not exceeding twenty times the width of the flange, the depth of a beam, h, is closely determined by the formula $h = \sqrt{1.2\ l\ W} + 1$, where l is the span in feet and W the center load in tons. And approximately for center loads for the standard plate girders tabulated in the Carnegie hand-book, with a fiber stress not exceeding 15,000 pounds per square inch, $h = \sqrt{l\ W}$. But for the ordinary crane beam, and similar uses which do not admit of side supports, the above formulas require modification.

They become with center loads: For beams, $h = \sqrt{1.2\ l\ W} + 1 + 0.004\ l^2$; for girders, $h = \sqrt{l\ W} + 0.004\ l^2$.

Of course these are based on the supposition that the beams are sufficiently long not to fail by crippling of the web—a case which almost never occurs in practice.

These formulas give a ready means for determining the size required for a given load and span without the use of tables and the usual trial-and-error methods; they are especially useful in the field, and for preliminary work. Up to the point where the length of the beam does not exceed seventy times the flange width, they will be found sufficiently accurate. Above this point the error slowly increases, but always on the safe side.

As with the original formulas, the correction given is not purely empirical, but is deduced from accepted laws. The result is surprisingly simple when the long road required to reach it is considered. The method may be of interest.

The manner of determining the proper coefficient for reducing the usual load to prevent undue strains in the compression flange when the beam is considered as a column, is well known; and different authorities give slightly varying figures. The Carnegie table is as follows:

When the length of a beam does not exceed 20 times the flange width, the coefficient for safe load = 1.
When the ratio does not exceed 30, coefficient = 0.9.
When the ratio does not exceed 40, coefficient = 0.8.
When the ratio does not exceed 50, coefficient = 0.7.
When the ratio does not exceed 60, coefficient = 0.6.
When the ratio does not exceed 70, coefficient = 0.5.

Changing the length to feet, and keeping the width in inches, this is equivalent to the following:

When the ratio, l in feet, w in inches = 1.7, coefficient = 1.
When the ratio, l in feet, w in inches = 2.5, coefficient = 0.9.
When the ratio, l in feet, w in inches = 3.3, coefficient = 0.8.
When the ratio, l in feet, w in inches = 4.2, coefficient = 0.7.
When the ratio, l in feet, w in inches = 5.0, coefficient = 0.6.
When the ratio, l in feet, w in inches = 5.8, coefficient = 0.5.

We now wish to substitute for w its equivalent value in terms of h. By plotting, and deducing an approximate formula for the curve, we find that $w = 1.4\sqrt{h}$ very nearly, this being a simple parabolic curve which closely averages the plotted points.

Substituting in the above, we have, for the first case,

$$\frac{l}{1.4\sqrt{h}} = 1.7. \quad \text{Reducing} \quad \frac{l}{\sqrt{h}} = 2.4, \text{ and}$$

$$\frac{l^2}{h} = 5.7.$$

Applying this method to the other ratios, as well, we have:

When ratio $l^2/h =$ 5.7, coefficient of load = 1.
When ratio $l^2/h =$ 12.2, coefficient of load = 0.9.
When ratio $l^2/h =$ 21.2, coefficient of load = 0.8.
When ratio $l^2/h =$ 34.7, coefficient of load = 0.7.
When ratio $l^2/h =$ 49.0, coefficient of load = 0.6.
When ratio $l^2/h =$ 67.0, coefficient of load = 0.5.

Plotting the above, it will be found that the straight line formula, coefficient = 1 — 0.008 ratio, gives practically the same coefficients. Therefore, coefficient for safe load, $C = 1 - \frac{0.008\ l^2}{h}$.

$$C = \frac{h - 0.008\ l^2}{h}$$

Now let W_1 represent the load in our original formula for plate girders, *i. e.*, $h = \sqrt{l\ W_1}$

Applying our coefficient for correction we have approximately, $W_1 = \frac{W}{C}$, and $h = \sqrt{\frac{l\ W}{C}}$. Squaring, and clearing of fractions, $h^2\ C = lW$. Substituting the value of C determined above:

$$\frac{h^2\ (h - 0.008\ l^2)}{h} = lW, \text{ and } h^2 - 0.008\ l^2 h = lW.$$

Completing the square, and solving for h:

$$h - 0.004\ l^2 = \sqrt{l\ W + (0.004\ l^2\ )^2}$$

The quantity $(0.004 l^2)^2$ is so small in comparison with lW as to be negligible, and we have finally, $h = \sqrt{lW} + 0.004\ l^2$, as first given.

By a similar process for I-beams, we have approximately:

$$h = \sqrt{1.2\ l\ W} + 1 + 0.004\ l^2$$

It is easy to point out discrepancies in the extreme cases of this method of averaging by simple curves, but the final tests show that the errors of the approximations are relatively small. The resulting formula is so simple that it can be solved mentally, and is close enough for all but construction work. A few comparative examples with extreme lengths are appended, to show their accuracy; shorter lengths give even more accurate determinations.

For this purpose, a size of beam and span are assumed, the safe loads taken from the tables and corrected for center load, and the usual correction applied for no lateral support, giving the net load for this condition. Then for comparison with this usual method, assuming this same net load and span to be given, the process is reversed, and the size of beam determined by the formula.

From the tables, reduced to center load:
24-inch I-beam, 36 feet span, 12.9 tons load.
$w = 7$ inches,
$36 \times 12 \div 7 = 62$,
$C = 0.6$,
$12.9 \times 0.6 = 7.7$ tons net safe load.
By formula:
$h = \sqrt{1.2 \times 36 \times 7.7} + 1 + (0.004 \times 36^2) = 18.3 + 1 + 5.2 = 24.5$ inches, required height of beam.

Similar extreme examples for smaller beams give the following results:

Beam =	18 inches	12 inches	6 inches	4 inches
$W =$	6.5 tons	3.3 tons	1.0 ton	0.4 ton
$l =$	36 feet	20 feet	30 feet	20 feet
$w =$	6 inches	5 inches	3 inches	2.66 inches
$\frac{12\ l}{w} =$	72	72	80	90
$C =$	0.5	0.5	0.4	0.3
$WC =$	3.3 tons	1.6 ton	0.4 ton	0.12 ton

Calculated by the formula the required heights of the beams, in inches, are the sums of the following:

12	7.6	3.1	1.5
1	1	1	1
5.2	3.6	1.6	1.6
18.2	12.2	5.7	4.1

In practical solutions, all decimals of feet and tons may be disregarded, using the nearest whole number, and the results obtained mentally will give the same beam. A few decimals were retained in the examples for the purpose of showing how closely the formula applies.

* Address: 204 West 111th St., New York.

* * *

A 2,000-kilowatt steam turbine installed in Rugby, England, has been placed on a rubber foundation and it is expected in this way to avoid objectionable vibration. The turbine is bolted to a concrete base 2 feet thick, which in turn, rests on several circular rubber stools, standing on a regular concrete foundation. Each rubber stool is a cylinder about four inches in diameter and three inches high when compressed by the weight of the turbine set. The idea of mounting turbines in this way is not new, but it is stated by *Engineering* that it has never before been tried with so large a turbine unit.

DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—5

GIRDERS

R. B. BROWN

The primary consideration when designing an overhead crane lies in selecting the correct type of main girders, since not only the general efficiency of the crane is affected by this question, but, as the girders usually represent the bulk of the machines, the subsequent success in competition largely depends upon the selection of an economical type. Coincident with the question of type is that of the factor of safety, or the working stress. Practically all crane girders are now built of steel sections made by the open hearth acid process, and usually specified to possess a tensile strength of from 28 to 32 tons per square inch.

A great variation of opinion exists on the question of working stress; while many cranes are made having girders stressed to only four tons per square inch and even less, others, will be found having above seven tons stress. Taking into consideration the fact that a general factor of safety of five seems to be usual and most desirable in crane work, it is necessary to limit the stress to one-fifth of the maximum breaking strength of the steel, which gives approximately 5½ tons per square inch.

There are four types of girders commonly used, *viz.*, box-plate girders, single web-plate girders, braced girders, and rolled beam girders. Each will be considered independently.

The simplest form of girder for spans up to about 40 feet is the rolled steel joist, and for light loads it is undoubtedly the cheapest type. The effective range of span and load for beam girders will be seen from Table IX which has been compiled to show the type of girder generally considered suitable for a given span and load.

For cranes up to 15 tons with spans too great for joists but not more than 65 feet, the best form of girder is the single web type. Up to 40 feet span, providing the traveling speed is not very high, these girders can be made to carry themselves and a light platform, if the flanges are moderately wide, but above 40 feet span these girders will be found weak laterally, and a subsidiary braced platform girder of light construction should be added, the same being braced horizontally to the main girder, as shown in Fig. 17. Although this type has been found somewhat costly, there is no doubt it is stiffer laterally than a box girder, and the single web girder always possesses the advantage of permitting inspection and painting, thereby avoiding deterioration from corrosion, such as occasionally takes place in box girders. For cranes above 15 tons and for spans up to 65 feet, however, the box girder is considered the best and cheapest type that can be used. The sections and proportions required by such loads generally ensure the girder being stiff enough to carry the platforms and cross-shaft without causing any lateral distortion.

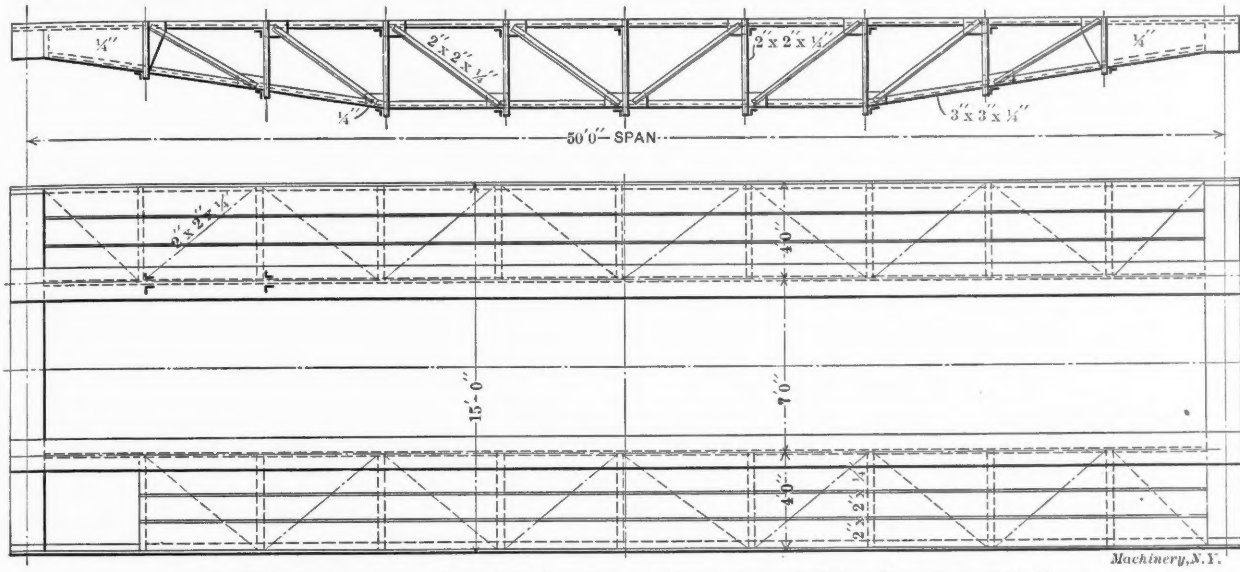
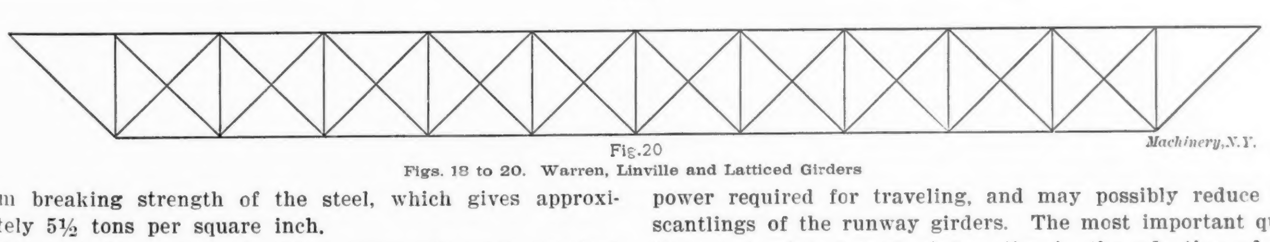


Fig. 17. Web-plate Girder with Braced Platform Girder, added to insure Sufficient Strength for Wide Spans

For cranes up to and including 4 tons, above 40 feet span and for all cranes from above 65 or 70 feet span, braced girders are the most economical. They are cheaper to make, and the reduced weight of the crane effects a saving in the power required for traveling, and may possibly reduce the scantlings of the runway girders. The most important question concerning braced girders lies in the adoption of the correct system of bracing, of which there are three designs in use, *viz.*, the Warren, the Linville and the latticed, as shown in Figs. 18, 19 and 20, respectively.

In point of cost, weight, and general convenience, the Warren type is the most suitable for the ordinary form of traveler. It has fewer joints and members, and gives satisfactory results in all respects. When the rolling load is large in proportion to the structural load, as is invariably



Figs. 18 to 20. Warren, Linville and Latticed Girders

the case with cranes, the Linville type requires so much counterbracing in the center, that it practically results in a latticed girder pure and simple, which, although frequently adopted, is heavier and more costly than the Warren type.

In order to treat the subject completely, it is proposed to consider the details of each type of girder, *i. e.*, solid, web, and latticed, independently, and although some parts may be a repetition, the arrangement will be more convenient to the designer.

Single Web, Box and Beam Girders

The preliminary calculation concerning the strength of girders of the above type is principally that of finding the bending moment in the ordinary way. This quantity should include the forces due to the rolling load of the weight and crab combined, the structural load due to the weight of the girder itself and the platform and cross shaft; and, if the driving motor is in the center, allowance must be made for this also.

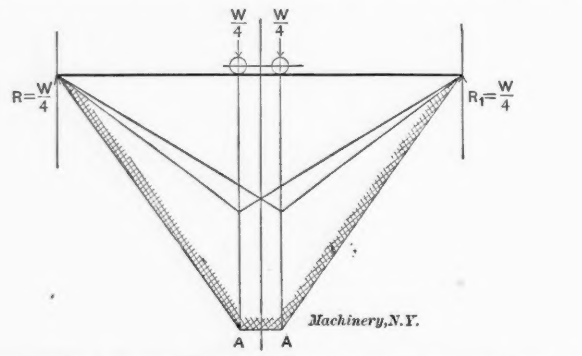


Fig. 21. Bending Moment Diagram, showing how the Effective Span of Girder is shortened by the Center Distance of the Crab Wheels

The practice of making some allowance for impact forces is neglected by the majority of crane builders, while, on the other hand, when work of this nature is undertaken by bridge builders, one finds as much as 50 per cent being added to the actual rolling loads to cover supposed impact forces.

TABLE IX. TYPE OF GIRDERS USED FOR DIFFERENT LOADS AND SPANS

R S B = beam section.
S W P = single web girder with lateral bracing girders.
B G = ordinary box girders.
L G = lattice girders, preferably Warren type.

Load in Tons.	Span in Feet.					
	30	40	50	60	70	80
5	R S B	R S B	S W P	S W P	L G	L G
10	R S B	S W P	S W P	S W P	L G	L G
15	R S B	S W P	S W P	S W P	L G	L G
20	R S B	S W P	S W P	S W P	L G	L G
25	B G	B G	B G	B G	L G	L G
30	B G	B G	B G	B G	L G	L G
40	B G	B G	B G	B G	L G	L G
50	B G	B G	B G	B G	L G	L G
60	B G	B G	B G	B G	L G	L G
75	B G	B G	B G	B G	L G	L G
100	B G	B G	B G	B G	L G	L G

That some allowance should be made appears quite consistent, particularly in high speed cranes, but there seems to be no definite rule for this. Generally speaking, the working stresses of crane girders, say 5 to 6 tons per square inch, provide a margin for small additional impact forces. No allowance will be made in the following calculations for impact stress, but such allowance could easily be added if considered necessary in any particular case.

If the crab is symmetrically built, the rolling load may be considered to be divided equally over the four wheels. By making this allowance it will be seen, as far as the rolling load is concerned, that the effective span of the girder is shortened by a distance equal to the center distance of the crab wheels. This can better be seen by reference to the bending moment diagram in Fig. 21, where it will be seen that the maximum bending moment from the rolling load occurs at $A\,A$, and is equal to the reaction at either support multiplied by the distance from that support to the center of the crab wheel. This quantity is also the bending moment at the center. To find the bending moment due to the structural load, it is usual to treat the latter as an evenly distributed load, where $M_b = \frac{WL}{8}$; similarly a traveling motor in the center of the span must be considered as a concentrated load, where $M_b = \frac{WL}{4}$.

A bending moment diagram might be drawn combining the whole of the above forces, but the same result can be found more quickly directly by figures, as shown in the following example.

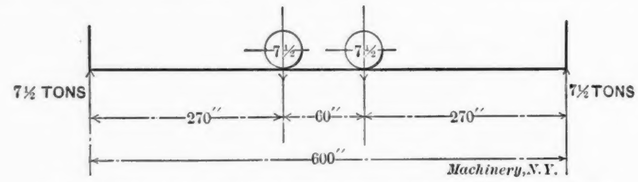


Fig. 22. Example for Calculating Bending Moment in Crane Girder

Find the total bending moment of a 25-ton crane, 50-foot span, weight of crab 5 tons, centers of wheels 5 feet. Approximate weight of one girder and platform, etc., 5 tons. Traveling motor in the center: weight ¾ ton. (See Fig. 22.)

$$\text{Bending moment, rolling load} = 270 \times 7\tfrac{1}{2} = 2025 \text{ inch-tons}$$

$$\text{Bending moment, structural load} = \frac{5 \times 600}{8} = 375 \text{ inch-tons}$$

$$\text{Bending moment, traveling motor} = \frac{3 \times 600}{4 \times 4} = 112.5 \text{ inch-tons}$$

$$\text{Total,} \quad = 2512.5 \text{ inch-tons}$$

When the maximum bending moment has been found, the depth of the girder must be considered. Modern practice generally makes this quantity the nearest even dimension equal to 1/15 or 1/16 of the span. In the case of heavy cranes, however, it is more economical to increase the depth of the girders than to make the flanges abnormally heavy, so that in the case of 100-ton overhead cranes of moderate span, the best proportion is about 1/12 of the span. An exception to the above rules occurs in the case of all short span cranes, where the depth becomes a matter of convenience.

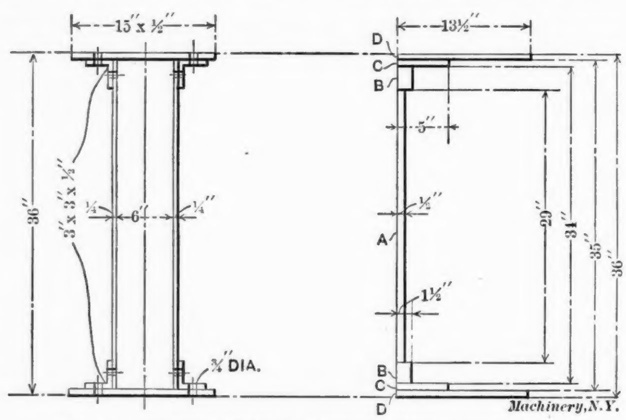


Fig. 23. Proposed Section of Girder, drawn to convenience its Calculation

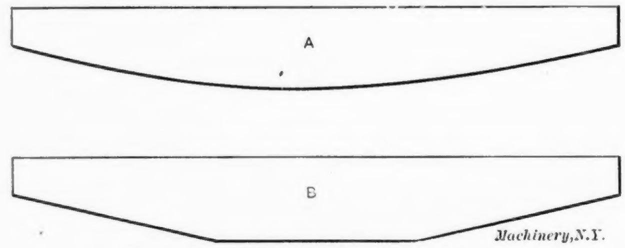


Fig. 24. Types of Fish-bellied Girders in Use

In determining the section of the girder it has, until quite recently, been common practice to totally ignore the value of the webs to resist bending, the flange area alone being

taken into consideration. This practice is open to some question; it seems that if the webs are stiffened in the usual way, they are of such value as to allow the whole section of the girder being taken into account, but in any case, the webs do not add much to the modulus. In order to calculate the strength, the moment of resistance or modulus of the section must be found; and this must be equal the bending moment divided by the working stress F in the girder:

$$\frac{M_b}{F} = Z$$

When finding a required modulus, the section has to be assumed, preferably by comparison, after the depth has been fixed. Allowance should be made for the rivet holes in the flanges to be ⅛ larger than the size of rivet. It is generally found convenient to draw the proposed section as shown in Fig. 23.

Before the modulus itself can be found, the moment of inertia of the section must be calculated. This quantity, for rectangular symmetrical sections taken about the neutral axis, is equal to 1/12 $b\,h^3$, when b = breadth and h = height of rectangle.

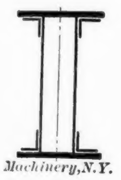


TABLE X. GENERAL DIMENSIONS OF BOX GIRDERS FOR ELECTRIC OVERHEAD CRANES, AND MODULUS OF GIRDER SECTION

Depth.	Flange, Inches.	Angles, Inches.	Webs, Inches.	Modulus.
2′-3″	12 x 3/8	3 x 3 x 3/8	1/4	230
2-3	12 x 1/2	3 x 3 x 1/2	1/4	292
2-6	12 x 3/8	3 x 3 x 3/8	1/4	273
2-6	12 x 1/2	3 x 3 x 1/2	1/4	308
2-9	12 x 3/8	3 x 3 x 3/8	1/4	314
2-9	12 x 1/2	3 x 3 x 1/2	1/4	380
3-0	15 x 3/8	3 x 3 x 3/8	1/4	378
3-0	15 x 1/2	3½ x 3½ x 1/2	5/16	530
3-6	15 x 3/8	3½ x 3½ x 3/8	1/4	500
3-6	15 x 1/2	3½ x 3½ x 1/2	5/16	653
4-0	18 x 1/2	3½ x 3½ x 3/8	5/16	797
4-0	18 x 5/8	3½ x 3½ x 1/2	5/16	940
4-6	18 x 1/2	3½ x 3½ x 1/2	5/16	998
4-6	18 x 5/8	4 x 4 x 1/2	5/16	1118
5-0	21 x 3/4	4½ x 4½ x 3/4	3/8	1809
5-0	21 x 1	4½ x 4½ x 3/4	3/8	2057

Referring to Fig. 23, it will be understood that, owing to its irregular shape, each rectangle A, B, C, and D must be treated independently.

The total moment of inertia of the section can, therefore, be stated as follows:

$$I = \frac{(36^3 - 35^3) \times 13\frac{1}{2} + (35^3 - 34^3) \times 5 + (34^3 - 29^3) \times 1\frac{1}{2} + 29^3 \times \frac{1}{2}}{12}$$

= 8,600 approximately.

It is well known that the modulus of moment of resistance of a symmetrical section is equal to the moment of inertia divided by the distance from the neutral axis to the extreme outer edge of the section; consequently the modulus Z of the

$$\text{section} = \frac{8600}{18} = 478.$$

Tables X and XI give approximate values of various box and single web sections suitable for crane work.

Although box girders have been made with 3/16-inch web plates, it cannot be considered good practice to use plates less than ¼ inch thick, owing to the small margin allowed for deterioration from rust. For box girders on cranes up to and including 20 tons, ¼-inch webs have been repeatedly used and show no signs of buckling with the ordinary arrangement of stiffeners. The same applies to 5/16-inch webs for 30- to 50-ton cranes; above this size ⅜-inch plates are recommended.

In the case of single web girders, ¼-inch plates have been used for cranes up to 7 tons, increasing to 5/16 inch up to 20 tons, and ⅜ inch or more, above, as required. When the stiffeners are placed outside, T-sections are generally used, but for cranes up to 10 tons, 2½- to 3-inch angles are amply strong enough, and also convenient for fastening the brackets. The various formulas for pitch of stiffeners used in bridge practice do not seem to agree with the results found in crane girders, since they usually give the centers of stiffeners unnecessarily close. The average practice is to place the stiffeners about 5 feet apart, but it is better to reduce this dimension to 4 feet 6 inches for girders up to 2 feet 6 inches deep. The practice of placing channels or Z-bars inside, instead of using outside T-stiffeners, generally necessitates some hand riveting; otherwise this is a neat and strong type.

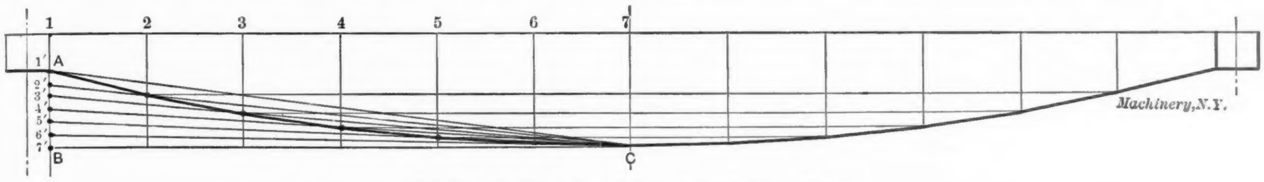


Fig. 25. Laying out a Girder of the A Type, Fig. 24

As shown in Fig. 24, there are two forms of fish bellied girders in use. The lower boom in both cases is polygonal, that in A having a side or flat for each division made by the stiffeners, while that in B has three straight cuts only, and is, therefore, cheaper; the general opinion is that both look equally well when erected. To find the varying depths in girder A, it is best to draw a parabola in the usual way, as shown in Fig. 25. The divisions 1 to 7 represent the centers of the stiffeners, and the distance $A\,B$ must be divided into the same number of equal divisions on each side of the center line of the girder. Drop verticals from 2, 3, and 4, etc., and join $C2'$, $C3'$, $C4'$, etc. The point of intersection between these two lines gives the depth of the girder at that point. Although the above method gives a well-shaped girder, it is not theoretically correct, since the parabola should be set off from the top flange. When this is done, however, the ends of the girder have to be parallel for a certain distance and this causes extra trouble in planing the webs, without any economy in material. In the case of type B, the correct parabola should be laid out, and the flats laid off to suit.

TABLE XI. GENERAL DIMENSIONS OF SINGLE WEB GIRDERS FOR ELECTRIC OVERHEAD CRANES, AND MODULUS OF GIRDER SECTION

Depth	Flange, Inches.	Angles, Inches.	Webs, Inches.	Modulus.
2′-3″	12 x 3/8	3 x 3 x 3/8	1/4	202
2-3	12 x 1/2	3 x 3 x 1/2	5/16	271
2-6	12 x 3/8	3 x 3 x 3/8	1/4	238
2-6	12 x 1/2	3 x 3 x 1/2	5/16	282
2-9	12 x 3/8	3 x 3 x 3/8	1/4	272
2-9	12 x 1/2	3 x 3 x 1/2	5/16	315
3-0	15 x 3/8	3 x 3 x 3/8	5/16	340
3-0	15 x 1/2	3½ x 3½ x 1/2	5/16	467
3-6	15 x 3/8	3½ x 3½ x 3/8	5/16	448
3-6	15 x 1/2	3½ x 3½ x 1/2	3/8	583
4-0	18 x 1/2	3½ x 3½ x 3/8	3/8	705
4-0	18 x 5/8	3½ x 3½ x 1/2	3/8	849
4-6	18 x 1/2	3½ x 3½ x 1/2	3/8	881
4-6	18 x 5/8	4 x 4 x 1/2	3/8	1002
5-0	21 x 3/4	4½ x 4½ x 3/4	7/16	1631
5-0	21 x 1	4½ x 4½ x 3/4	1/2	1917

For girders up to 40 feet span which are going to be shipped in one piece, it is possible and preferable to have

the flange plates and angles in one length, and thereby avoid the joints. When, however, joints are necessary in the flanges, it is the practice of some makers to allow 25 per cent extra section for the rivets, and the flange joint plates and angles should be of the same section as the flanges themselves, at least.

For cranes traveling at a moderately high speed, that is, anything over 200 feet per minute, the lateral stresses due to suddenly stopping the load require consideration. If, for example, the 25-ton crane previously referred to travels at 300 feet per minute (5 feet per second) under full load, the momentum of the load and crab at full speed will be $\frac{W v^2}{2 g}$

$$\text{or } \frac{30 \times 5^2}{64.4} = 11.6 \text{ foot-tons.}$$

It is difficult to assume what would be the least distance that the crane would travel before coming to rest after the

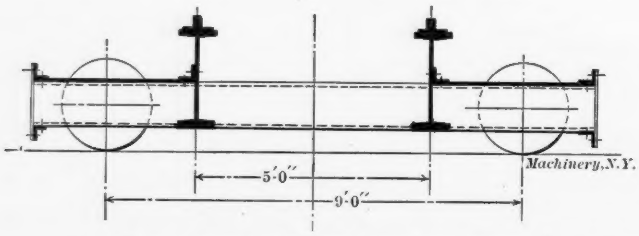


Fig. 26. Method of Stiffening Steel Joist Girders

current had been shut off and the brake had been applied, but a minimum of five feet has been found satisfactory, and under this condition the average horizontal force on the two girders would be $\frac{11.6}{5} = 2.3$ tons, or 1.15 ton per girder. This would be the concentrated effort, but there is also the distributed effort due to the girder itself, which will be found by the above formulas to be about 0.95 ton per girder.

In order to avoid possible distortion from the concentrated load, one must assume that it is carried by the upper part of the girder only, that is, the flange plate, angles and about 18 inches of the webs. The bending moment from the concentrated load, in the above example, allowing for the spacing of the crab wheels, is $0.57 \times 270 = 154$ inch-tons.

The modulus of the upper flange taken horizontally is 45.7, therefore, the stress is $\frac{154}{45.7} = 3.4$ tons per square inch.

The distributed load is carried by the full depth of the girder, and, allowing for the horizontal modulus of the whole

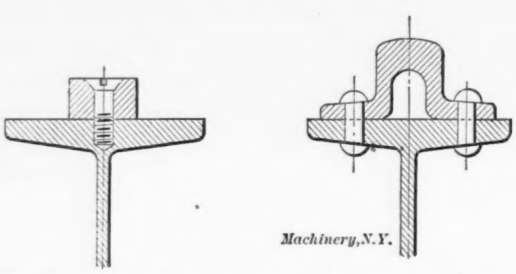


Fig. 27. Methods of Attaching the Rail to the Beam Girder

of the section, gives a stress equal to about 0.7 ton per square inch, bringing the total lateral stress up to $3.4 + 0.7 = 4.1$ tons per square inch.

The total lateral stress should not exceed four tons per square inch under the above conditions, since the ratio between flange width and span, which is usually about 1 to 40, is large, and the girder is, therefore, more easily deflected.

By referring to Table IX it will be seen that rolled steel beams can be used for cranes of varying capacity, up to 40 feet span. The most economical and only really practicable method of using steel beams for moderate-speed and high-speed cranes is to attach a steel chequer-plate platform to both girders in such a manner as to provide the necessary lateral stiffness. Fig. 26 shows a typical form of this arrangement.

There are two common methods of fixing the rails on the beams, either by riveting on a bridge section rail, or screwing on a flat bar, as shown in Fig. 27. Both methods are equally satisfactory.

[In the fourth installment of this series, published in the April issue, two errors occurred in the numerical calculations. At the top of page 578 the calculation of the weight required for mechanical brakes should have been, theoretically, 127 pounds, instead of 12.5 pounds, and the weight with the extra allowance about 150 pounds, instead of 15 pounds, for the conditions given. The numerical example for a brake of the friction disk type also contains an initial error which makes the subsequent results erroneous. The formula given, however, is correct. Those who file these articles should, therefore, make note of this in the places referred to, so that confusion may be avoided when the matter is referred to in the future.—EDITOR.]

* * *

ANTI-FRICTION ALLOYS FOR BEARINGS*

The load at which rubbing begins is generally greater, the harder the metals in contact; the coefficient of friction on the other hand is generally smaller, the harder the metal. In order to reduce friction as well as to avoid cutting, hard substances should be used for bearing surfaces—hence the use of phosphor bronze.

The use of hard substances, however, corrects only the effects of defective lubrication, and assumes that the surfaces in contact are regular, so that the load is uniformly distributed and not concentrated in certain points. If the metal is hard and unyielding, the pressure on these points becomes considerable and leads to heating and cutting. Hence the bearing metal must have a certain plasticity so as to mold itself around the shaft and increase the surface of contact. But the bearing itself is constantly wearing away irregularly, and the plasticity of the metal must be such as to constantly restore its contact with the shaft.

We are led, therefore, to seek in alloys for bearings subjected to friction, two apparently contradictory characteristics, namely, hardness and plasticity. We may combine them, however, in using metals composed of hard grains embedded in a plastic matrix, and this is the main principle aimed at in anti-friction alloys.

The constitution of bronzes is the reverse of that of white alloys. Instead of hard grains in a plastic eutectic, we have soft grains in a hard eutectic for the same degree of plasticity. The behavior of bronze and white metals is not identical, and the bronze has a greater tendency to cut than the white alloys.

If the weight borne by the bearing of a uniformly-rotating shaft be gradually increased, when a certain load is reached the oil is driven from the space between the shaft and the bearing, and the metal becomes heated. In the case of white metal the wear is then considerable, and if the load continues to increase, the alloy may be partially fused. In the case of bronze, the portions rich in copper adhere to the shaft, forming a rough surface and increasing the friction.

Bronzes are then inferior to white metals because they are less plastic and do not mold themselves as well around the axle; their greater strength does not permit a heavier load, for then the lubrication is interfered with, and they tend to become heated. Bronzes, on account of their constitution, have a greater tendency to cut than white alloys, and thus produce a deterioration of the axle.

An anti-friction alloy should have hard grains in a plastic matrix; then the load is carried by the hard grains which have a low coefficient of friction, and the cutting can only take place with difficulty. The plasticity of the cement makes it possible for the bearing to adjust itself around the shaft, thus avoiding local pressures, which are the chief cause of accidents. Such properties may be obtained in binary alloys with such metals as antimony, tin, and copper, which form chemical compounds. The requisite properties are better obtained in ternary alloys, which give a good plastic matrix (eutectic). To test an anti-friction alloy, compression and the microscope are invaluable aids.

* Extract from paper by Mr. A. H. Hiorns, read before the Birmingham Association of Mechanical Engineers, December 17, 1908.

SPECIAL AUTOMOBILE FACTORY TOOLS AND DEVICES*

ETHAN VIALL†

The things that impress a visitor most as he goes through the great automobile factory of the Geo. N. Pierce Co., Buffalo, N. Y., are the splendid buildings, the magnificent lighting and the immense floor spaces. An idea of the size of the plant may be obtained from the following dimensions of the various buildings that make up the group. The office building is 250 by 67 feet and consists of two stories and a basement, the first floor being used for offices, the second as a dining hall, smoking and club room, while the basement contains closets, individual lockers, bicycle racks and long rows of white enameled wash bowls. Next is the manufacturing building, 401 by 205 feet; the assembly building, 410 by 122 feet; the brazing building, 377 by 55 feet; the power house, 194 by 55 feet; the garage, 139 by 55 feet; and the motor testing building, 91 by 43 feet. All of these, except the office building, are of the one-story saw-tooth roof type. Then there is the three-story body building, where the automobile bodies are set up and finished, the north wing of which is 327 by 60 feet; south wing, 401 by 60 feet, and the east wing, 50 by 40 feet. The floor space represents over 360,000 square feet, and the plant is as nearly fireproof as it is possible to make it, being almost entirely concrete with no more wood anywhere than is absolutely necessary.

There are in the factory many very interesting features, viewed from an engineering standpoint, but as this article is to deal principally with special tools and devices, other features not coming under this classification will merely have passing mention.

In the construction of the Pierce Great Arrow car, aluminum is very extensively used; bodies, crank-cases and many other parts being made of this metal. The method of milling the ends of the crank-bearings in the aluminum crank-cases is shown in Fig. 1. A finished crank-case is shown leaning against the machine, while another is clamped to the angle-plate ready to be milled. The lubricant used is a soap-water mixture. Fig. 2 shows the machine that bores out the crank and cam-shaft bearings in one operation, using three boring-bars. In connection with the finishing of these crank-cases, the arrangement shown in Fig. 6 is very useful. It consists of an air-drill to which has been fitted a bracket and taper mill as illustrated, and it is used for trimming off the bosses in order to save chipping and filing. The machine produces a smooth finish quickly and it is easily operated.

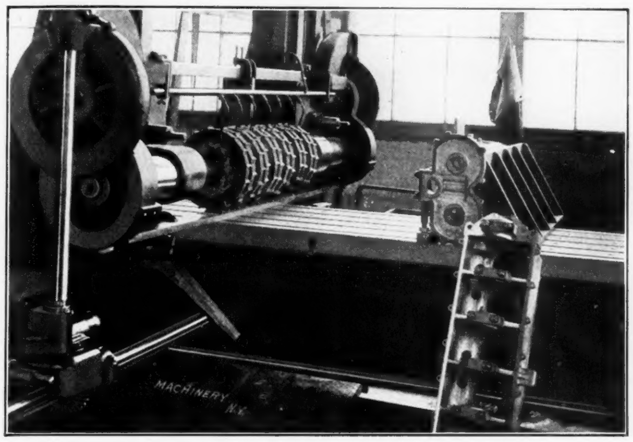


Fig. 1. Milling the Ends of the Bearings of Aluminum Crank Casings for Pierce Automobiles

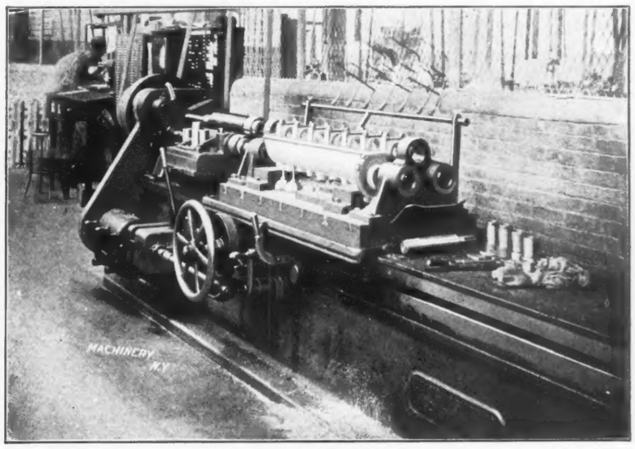


Fig. 2. Machine for Boring the Crank and Cam-shaft Bearings at the Same Time

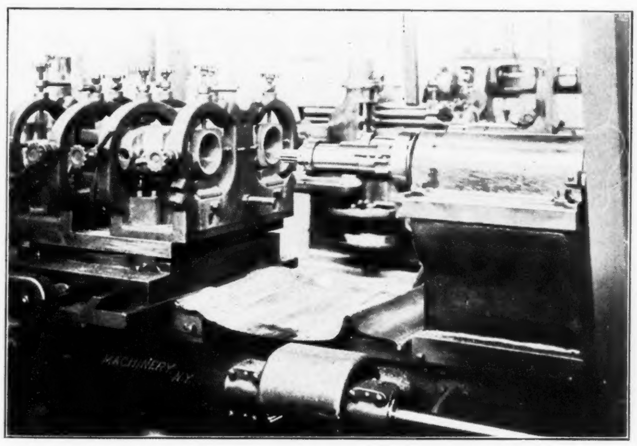


Fig. 3. Lathe Fixture for Holding Four Cylinders while They are being Rough Bored

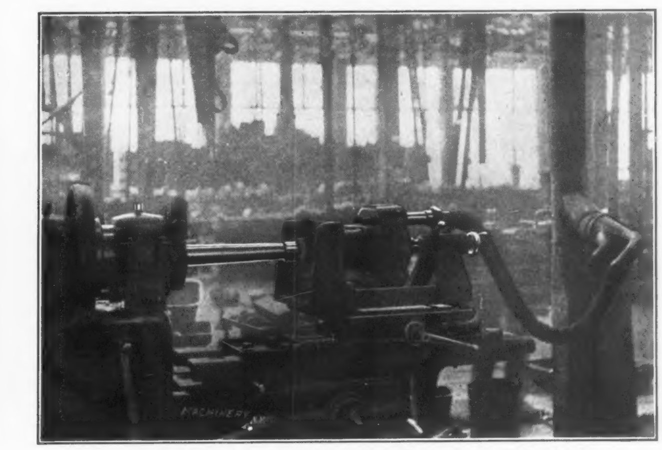


Fig. 4. Grinding the Cylinders—The Hose to the Right is for Carrying away the Dust

Machining the Cylinders

The fixture used to hold the cast-iron cylinders while rough-boring, is shown in Fig. 3. After "seasoning," the cylinders are ground on the machine shown in Fig. 4. In this machine the cylinder remains stationary and the emery wheel is rotated around the bore as it grinds. The loose emery and metallic dust is removed through the hose which is coupled to the cylinder, and which is connected with the piping of a powerful suction fan system. A jig for holding cylinders while drilling, reaming or tapping the various holes, is shown in Fig. 7, and a complete set of valve-hole finishing tools is shown in Fig. 5.

Roughing Out Piston Rings

The piston-rings used in this shop are roughed out in a different way from any the writer has seen elsewhere, though they are finished on the grinder in the usual manner. A view of the specially fitted machine used, is shown in Fig. 8. This view was taken from above, back of the turret and looking toward the chuck. The inside of the ring casting is bored by means of a boring-bar in the turret, guided by a bushing in the spindle, which is the general practice. The outside is also turned eccentric at the same time by means of a sliding tool-carriage and an eccentric cam-ring *A*, acting on the guide *B* which causes the carriage and turning tool to feed in and out as the spindle rotates with the work. The small cam *C*, placed on the outside of the cam-ring *A*, is used to operate a special mechanism for notching the rings at their thinnest point in order to facilitate the splitting operation,

* For previous articles on this subject, see Drop Forge Work in an Automobile Shop, September, 1908; Organization and Equipment of an Automobile Factory, March, 1909; Special Tools and Devices for Automobile Factories, April, 1909, and Autogenous Welding as a Means of Repairing Cylinders, April, 1909.

† Associate Editor of MACHINERY.

which is done on a milling machine. As the cam-ring turns, cam *C* comes into contact with the part *D* which is pushed outward pulling with it the part *E*, which causes a little tool at *F* to notch or mark the casting at its thinnest point, as if it had been struck with the edge of a sharp chisel. Before this notching device was put on the machine, the rings were notched in the tool shown in Fig. 9, which has an indicator needle at the bottom to indicate the thickest part of the ring, thus locating the thinnest place at the top where it is to be split by a saw. The ring is clamped by means of an eccentric lever which pushes up the block *K*. Of course the testing of each separate ring to find the thinnest part took a great deal more time than is required when the rings are automatically marked at the proper place before being cut off from the original casting by the gang tool.

Machining Small Cams, and Balls for Ball-and-Socket Joints, —Construction and Use of Special Fixtures, etc.

Small cams used for valve lifting are turned by being keyed in place on a mandrel having a master-cam which operates a sliding carriage holding the cutting tool, as shown in Fig. 10. The carriage guide is held up to the master-cam by a weighted chain running over a pulley as shown.

The balls on the ends of levers used in ball-and-socket joints and for other purposes, are turned in a lathe by using the device shown in Fig. 12. The height or radius of the cutting tool and, consequently, the size of the ball turned, is regulated by the screw *A*. The tool is swung around in an arc by turning the handle *B* which is fastened to a worm meshing with an enclosed worm-gear.

The pin holes for the front-axle steering-knuckles are drilled and reamed in the jig, Fig. 13, while the differential gear cases on the rear axle, are held as shown in Fig. 11, when the holes for the clamping bolts are drilled.

Many of the cap-screws used are too large, so to avoid trouble in the assembling room, the threads are resized in the device shown in Fig. 14. This is a hand-machine, the spindle of which has a chuck at the lower end, and into this is placed a socket-wrench fitting the heads of the cap-screws to be re-cut. Clamped to an angle-plate below the spindle, is a die and holder as illustrated. A boy can accurately size a large number of screws in a day at a very small expense. For slotted-head screws, a screw-driver is used in the chuck in place of a socket wrench. Undersize nuts are also retapped in this machine by putting a tap in the chuck and using a special socket to hold the nuts.

Bevel gears are hardened and the rough hole is then trued up and ground to size on the machine shown in Fig. 15, the chuck being shown in detail in the line engraving Fig. 28. As will be seen from this illustration, the gear is centered in the chuck by a sliding cup which is pushed forward by a long bolt (not shown) which passes through the hollow spindle of the machine. As this bolt is screwed in, it moves the sliding cup (with the bevel gear in it) forward until the large end of the gear comes in contact with the removable front plate; then only a slight turn is needed to lock it firmly and centrally in place. An end view of another chuck

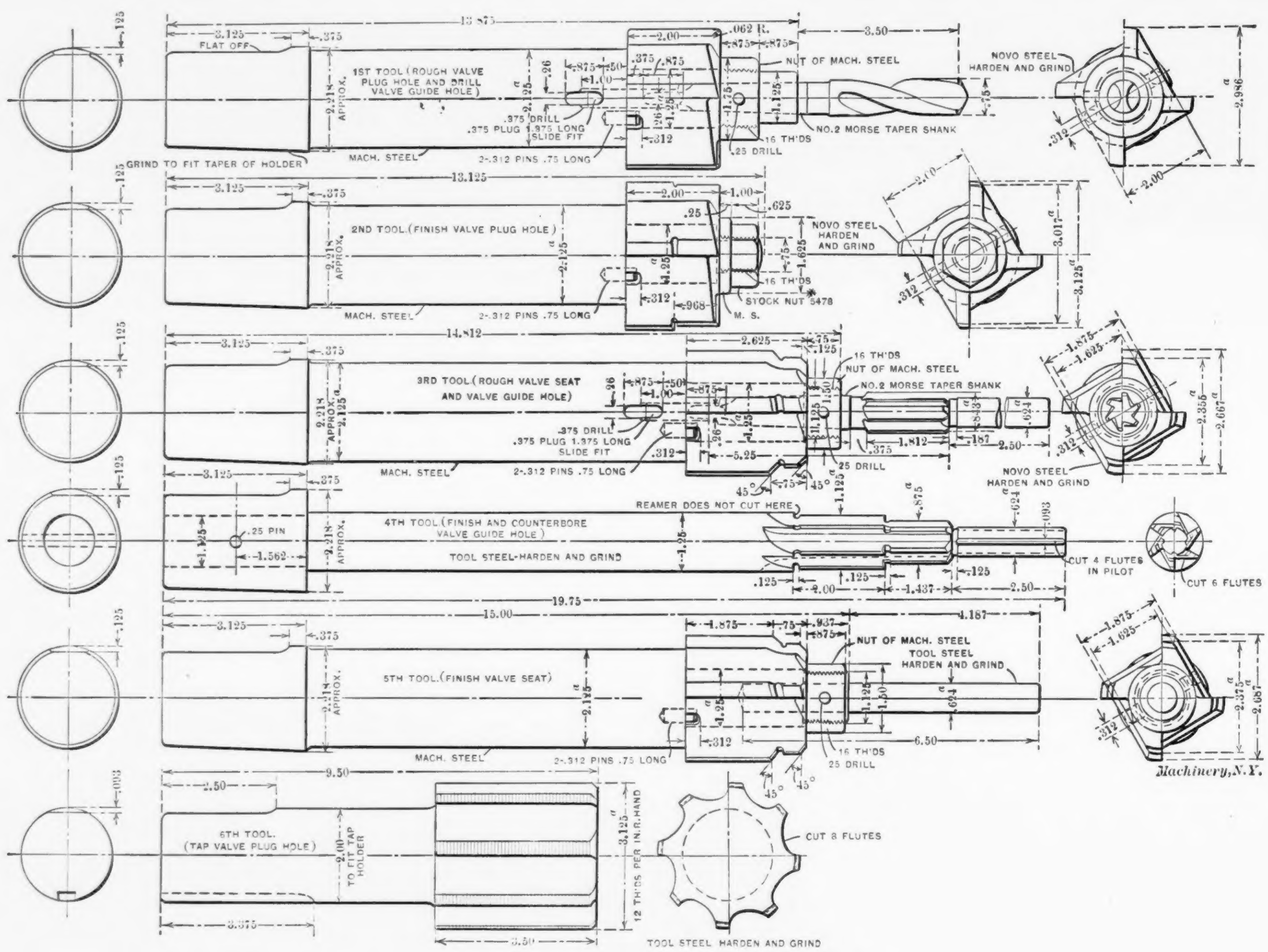


Fig. 5. Complete Set of Tools for Finishing Valve Holes.

used for holding a number of different sizes of spur-gears while grinding the hole, is shown in Fig. 16.

A special milling fixture used for backing off the teeth of three-toothed claw-clutches, is shown in Fig. 17, and in detail in Fig. 29. In using this device, the milling cutter and clutch blank are placed in the proper relation to each other, and the pin *A* is placed against the stop-pin *B*. The hand lever *C* is then slowly pushed forward in the direction indicated by the arrow. This movement is transmitted, through clutch *D*, to the screw *E* the lead of which determines the angularity of the face *F* of the clutch tooth. When the pin *G* strikes the stop-pin *B*, one cut is completed. The lever *C* and the screw *E* (against which the clutch *D* is pressed by the springs shown) is then turned back, the screw moving 120 degrees or until pin *A* strikes *B*, and the lever and the work moving 240 degrees or until clutch *D* turns in relation to screw *E* 120 degrees after the movement of the latter has been arrested by the pins *A* and *B*. Clutch *D* is

then again forced into engagement with the screw by the springs shown, and in this way the work is indexed for the next cut.

Except for the working of the lever for each cut, the device is automatic in action, as the teeth are cut exactly alike and an equal distance apart, and as the hand lever is drawn back to index, the clutch blank is also drawn away from the cutter and placed in position for the next tooth.

and placed as at *D*. The space between the bushing and the half-mandrel is then filled with babbitt from the kettle *C*. An immense amount of brazing of all kinds is done in this factory, and the form of brazing-torch and stand used is shown in Fig. 22.

The Inspecting Department

The department where the machined parts are inspected is in charge of Mr. W. C. Wenk, and it is one of the most

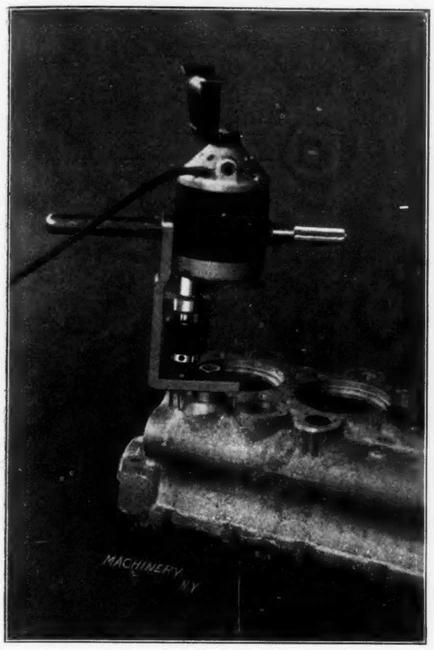


Fig. 6. Air Drill with Taper Mill used for Trimming the Crank-case Bosses

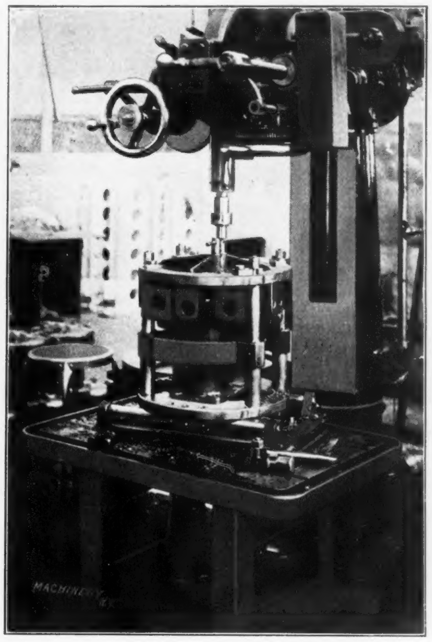


Fig. 7. Jig for Holding Cylinders while Drilling, Reaming or Tapping the Various Holes

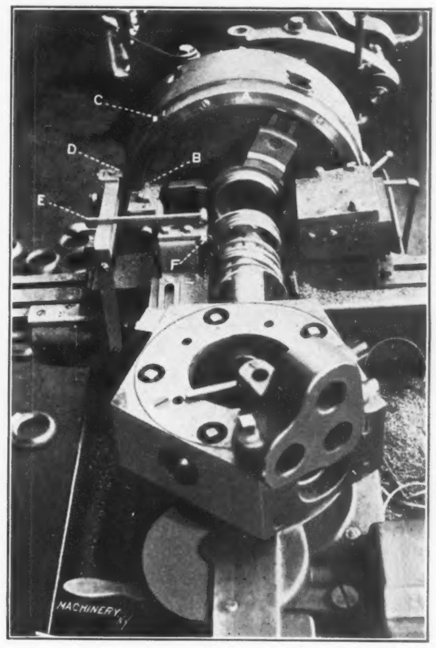


Fig. 8. Machine for Boring the Inside and Outside of Eccentric Rings simultaneously

A fixture used while slotting the quadrants for the change gear lever, is shown in Fig. 18 with a finished quadrant in place. As the bushed pin holes in the side of the device show, the quadrant can be placed in four different positions, corresponding to the several slot ends, without removing it from the fixture.

important in the factory, for upon it depends, to a great extent, the reputation of the output. Many of the inspecting tools and gages used here have been designed especially for the work by Mr. A. F. Wisner, the chief-draftsman, who has also, in conjunction with Chief Engineer Ferguson, designed a large part of the special tools which have been already

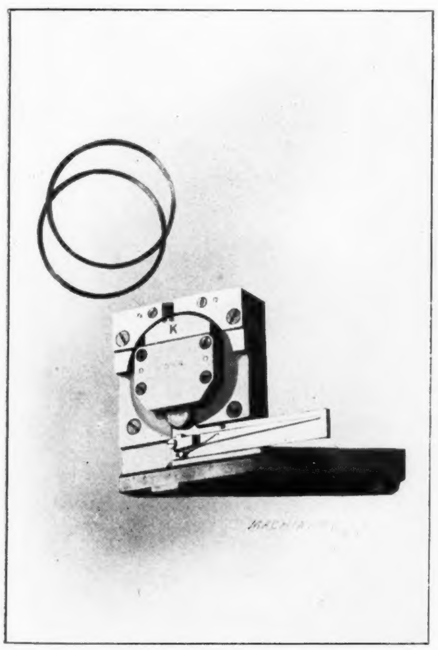


Fig. 9. Tool formerly used for Locating the Thinnest Part of the Rings prior to Splitting

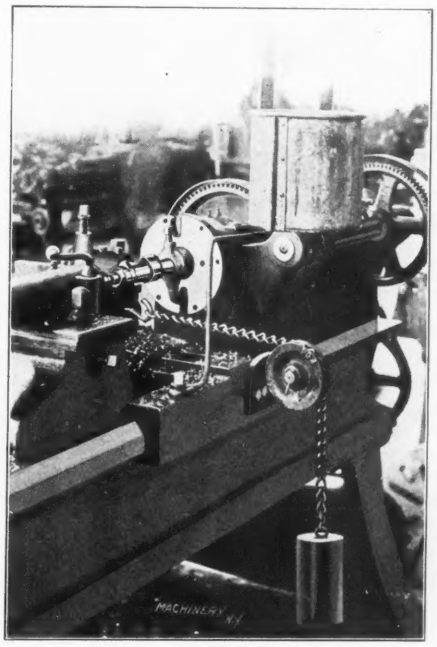


Fig. 10. Machine arranged for Turning Valve Cams

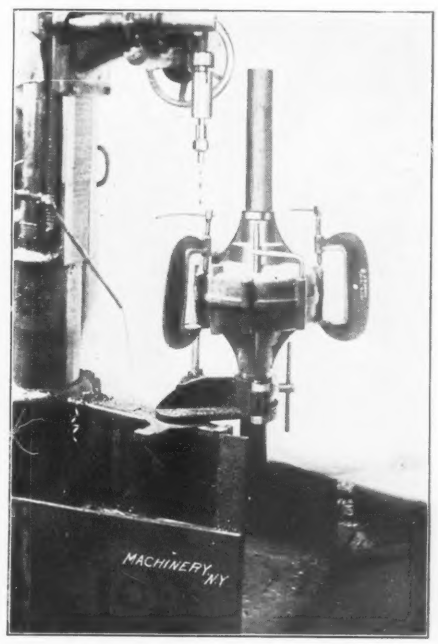


Fig. 11. Drilling Bolt Holes in the Differential Gear Case

In Fig. 19 are shown two expanding arbors, and in Fig. 20, three forms of drilling jigs with different locking devices on each.

Brass bushings used in some of the bearings are lined with babbitt in the type of jigs shown at *A* Fig. 21. The bushings are first heated on a flat iron plate *B* and then tinned on the inside with acid and common wire solder. This tinning is done so that the babbitt will adhere firmly to the brass, as it would otherwise have a tendency to peel off. After being tinned the bushings are clamped as shown at *A*

shown. The inspection methods of Mr. Wenk and his men are very thorough and no chances are taken on poor workmanship or castings that "might do." All work is taken to the inspecting room after each complete operation, and O. K.'d or rejected before it has a chance to go onto another machine. In this way, a piece that has been spoiled is scrapped before any more useless work has been put on it. As soon as a piece of work has been found that does not come up to the standard requirements, a "Scrap Material" tag like the one shown in Fig. 30, but fully filled out, is attached to it. Three

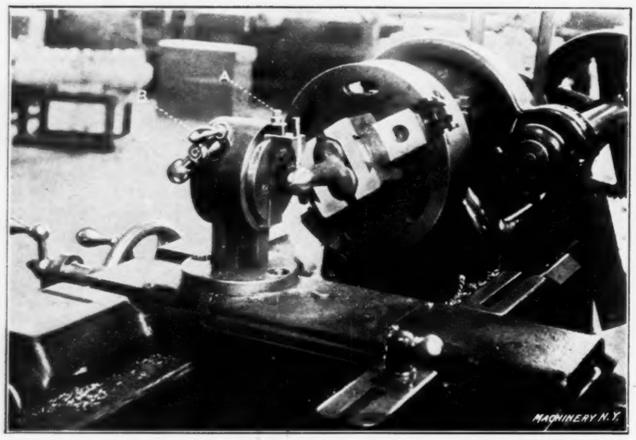


Fig. 12. Attachment for Turning Spherical Ends of Different Diameters for Ball-and-socket Joints

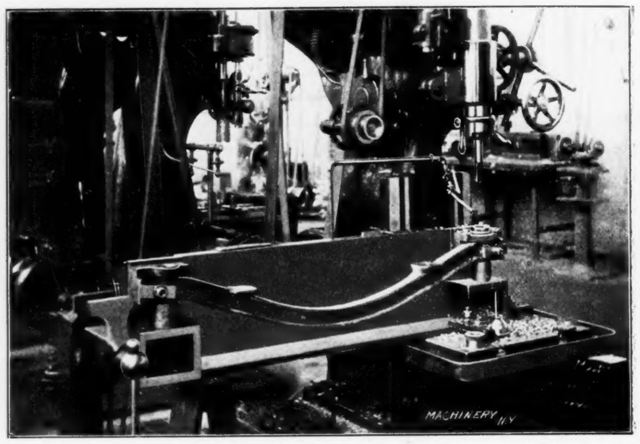


Fig. 13. Drilling and Reaming Pin Holes in the Front Axle for the Steering Knuckles

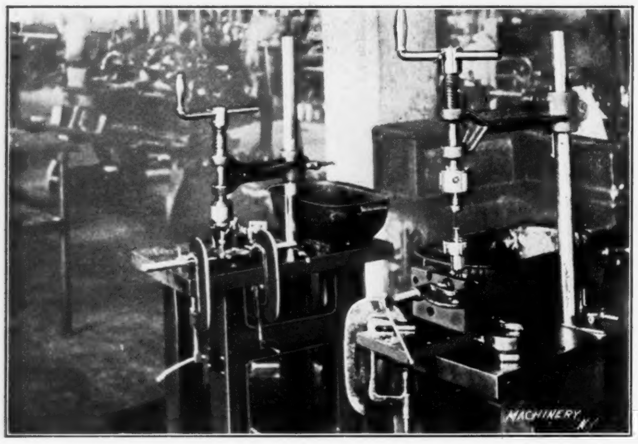


Fig. 14. Small Hand-operated Machines for Re-cutting Cap-screws or Re-tapping Nuts

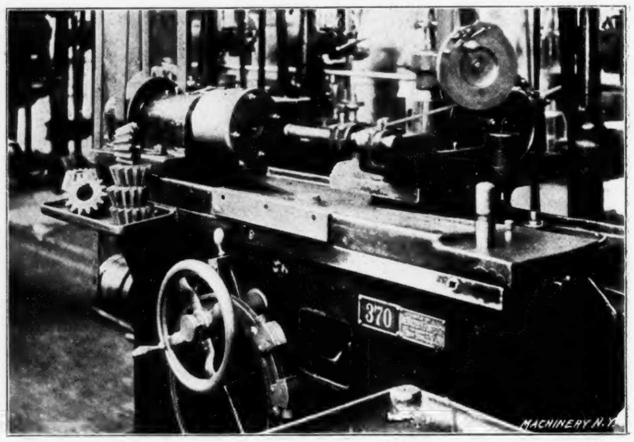


Fig. 15. Grinding the Hole in a Hardened Bevel Gear—See Detail of the Chuck in Fig. 28

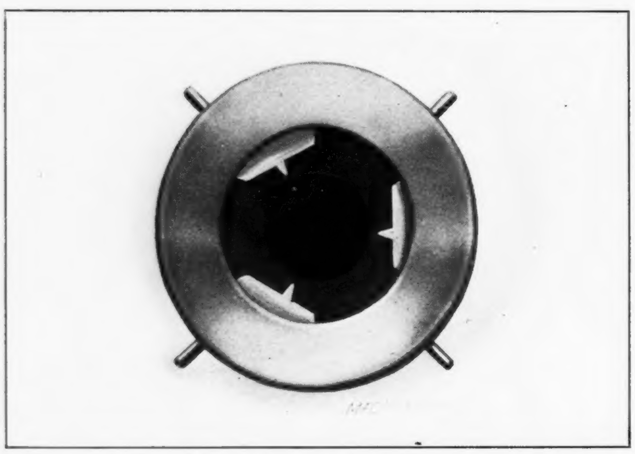


Fig. 16. End View of Chuck for Holding Spur Gears when Grinding the Holes

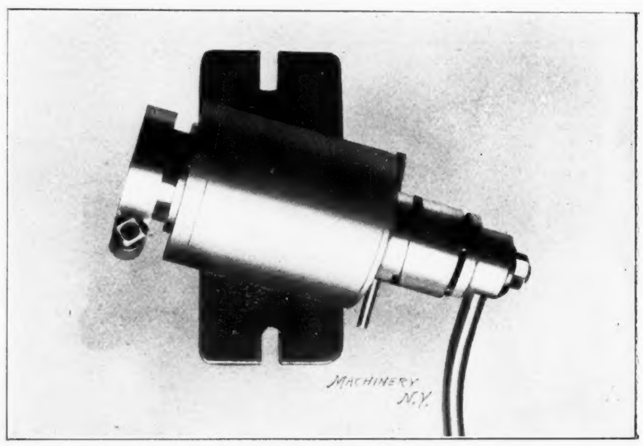


Fig. 17. Fixture for Holding Three-tooth Claw-clutches when Milling the Teeth

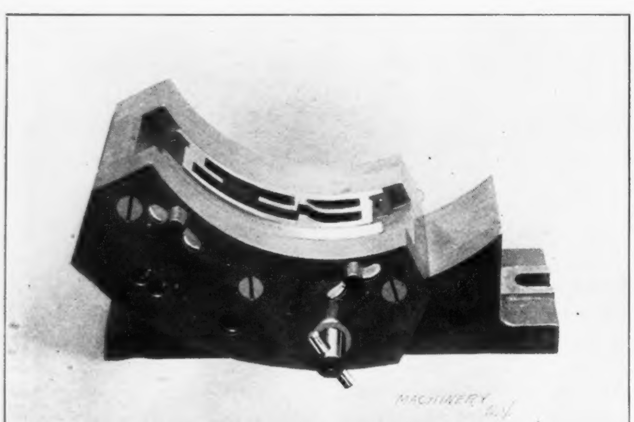


Fig. 18. Slotting Fixture for the Quadrant of the Change Gear Lever

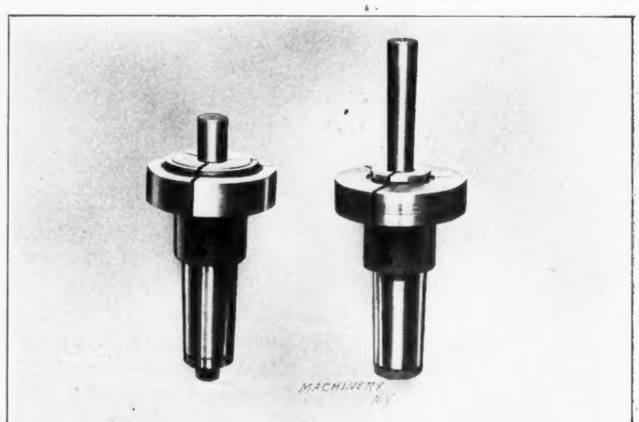


Fig. 19. Two Expanding Arbors

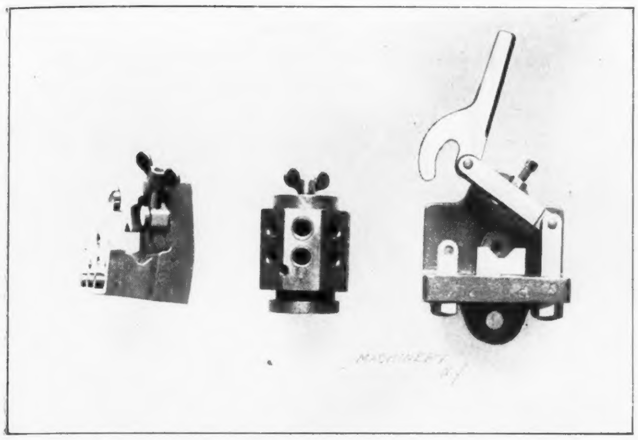


Fig. 20. Three Types of Drill Jigs, each of which is equipped with Different Locking Device

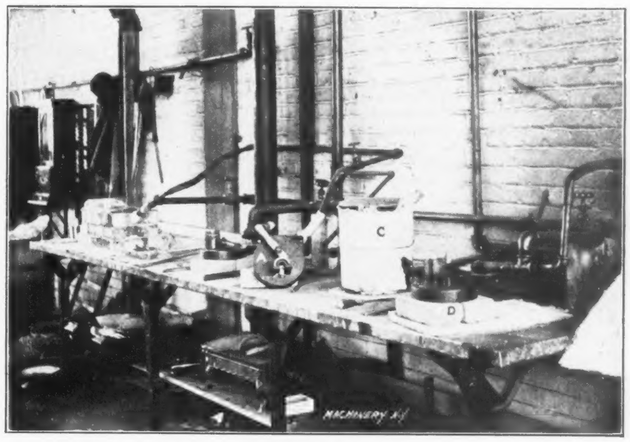


Fig. 21. Bench where Brass Bushings used in some of the Bearings are lined with Babbitt

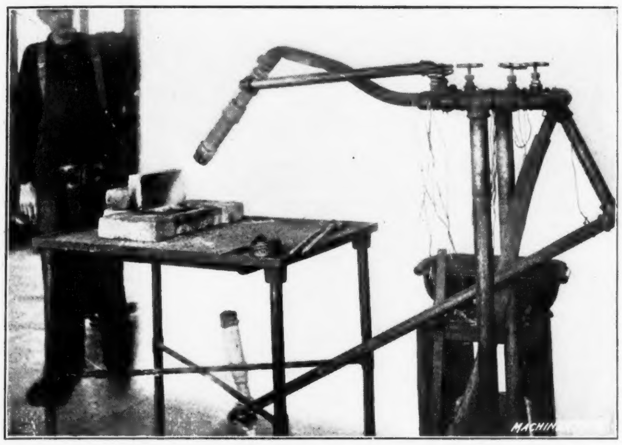


Fig. 22. A Simple and Inexpensive Form of Burner and the Stand which are used for Brazing

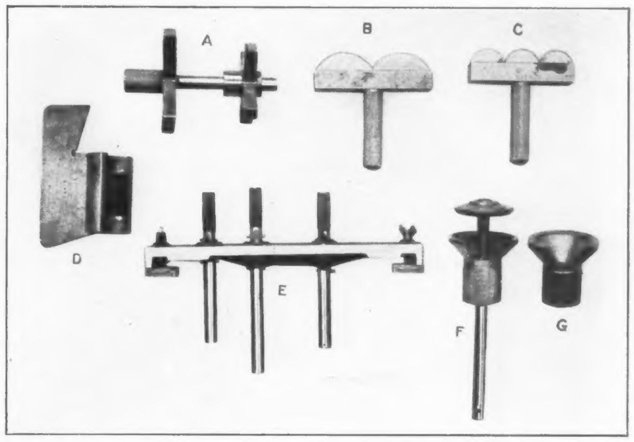


Fig. 23. Some of the Gages used in the Inspecting Department for Testing the Accuracy of Keyseats, Valves, Bevel Gears, etc.

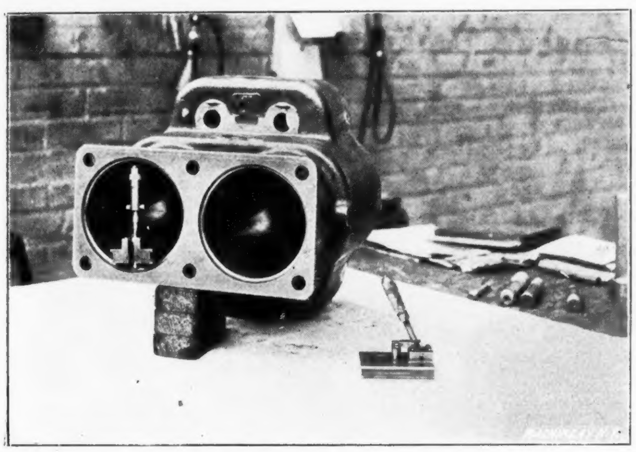


Fig. 24. Micrometer Gage for Testing the Size, Roundness and Parallelism of the Cylinder Bores

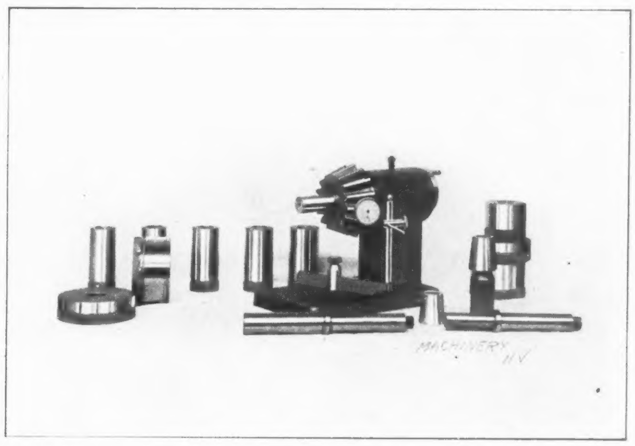


Fig. 25. Starrett Indicator and Stand used for Testing the Accuracy of Gears of Various Kinds and Sizes

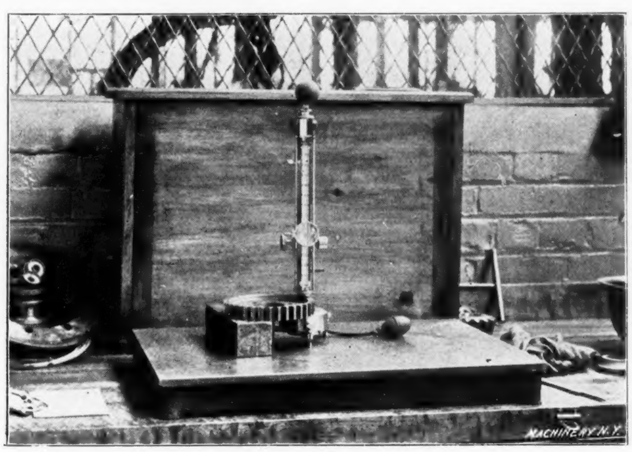


Fig. 26. Testing the Hardness of a Gear with a Sclerescope

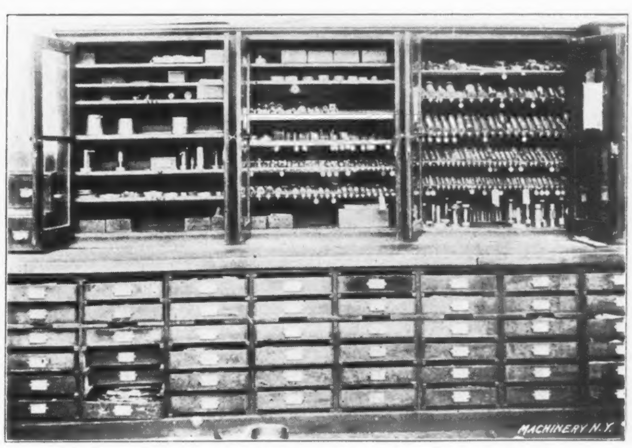


Fig. 27. One of the Gage Cases in the Inspecting Room

duplicate report slips like those shown in Fig. 31 are then made out and one copy filed in the inspecting room, one sent to the general foreman and the other to the cost department. In this way a complete record is kept of all work and the man at fault easily traced. The work of handling the small parts is greatly facilitated by placing them in large, oblong, pressed-steel pans, and wheeling them from place to place on low four-wheeled trucks.

Fig. 23 shows some of the gages used; A is a double "star" gage for testing the size and alignment of the opposite ends of a hub; *B* and *C* are Woodruff key-seat gages for testing the size, depth and alignment of two and three key-seats, respectively; *G* is a valve bevel, size and stem gage which is used as shown at *F; E* is a gage for testing the size, distance, depth, straightness and alignment of three holes; and *D* is for testing a bevel gear and its shaft position. Fig. 24 shows an inside micrometer caliper fitted to a special base, which is used for testing the bore of cylinders for size, roundness and parallelism. As the one on the bench shows, the micrometer head can be laid flat or placed upright when it is held in place by spring clips. The special base makes it easy to detect small hollows or other faults that might otherwise escape notice. Fig. 25 shows a stand and a Star-

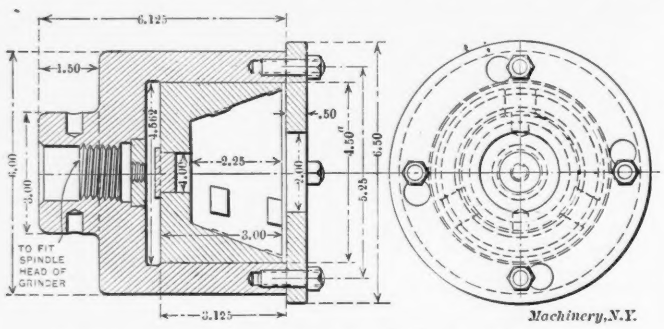


Fig. 28. Detail of the Chuck used for Holding Bevel Gears when Grinding them, as illustrated in Fig. 15

rett indicator, used to test gears of various kinds and sizes. The plug or spindle on which the gear is placed, acts as a gage for the hole, while the indicator shows how much the outside of the teeth are out. Gages and bushings for other sizes of gears are also shown in this illustration. Fig. 26 shows the sclerescope used to test the hardness of all gears and other hardened parts. A view of one of the gage cupboards is shown in Fig. 27.

Testing the Motors

The motor testing department is in a building by itself some distance from the main group. Here all engines are required to run a large fan, as shown in Fig. 32, at a certain speed for seventy hours, before being allowed to go into an automobile. This method of testing is probably the most satisfactory way of getting at the real power of a motor. The

table in large dishes or platters and the men help themselves to all they want, at a straight charge of fifteen cents each. The necessary waiters are provided by having the men in the inspection department quit work at 11:30, eat their dinner, and then serve the rest. A glance at the engraving will show that the dining room compares favorably

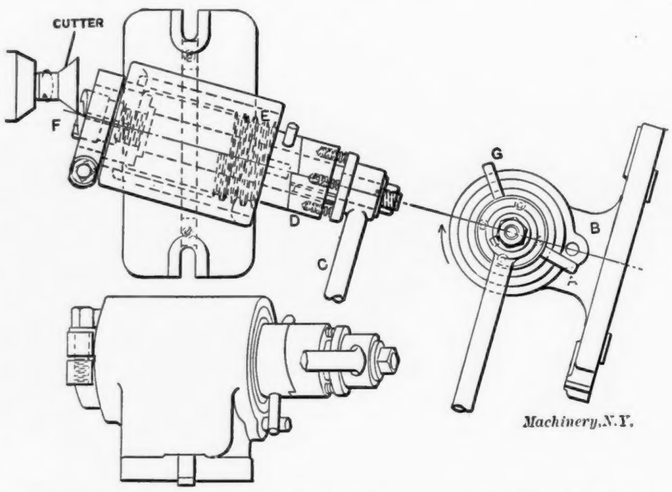


Fig. 29. Plan and Elevations of the Clutch Milling Fixture shown in Fig. 17

with many of the higher-class restaurants in its fittings, and as to the quantity and quality of the food, the writer can say from personal experience that it is first class in every way.

* * *

The Comptroller-General of Patents of Great Britain has ordered a patent owned by the British Westinghouse Electric & Mfg. Co., relating to electric-arc lamps, to be revoked on the

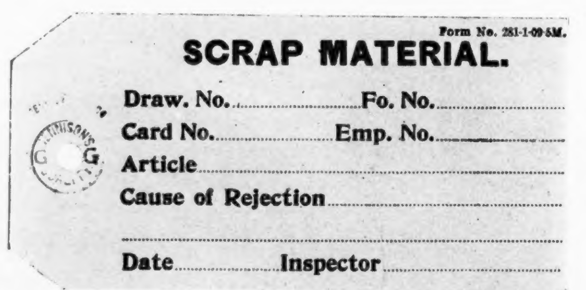
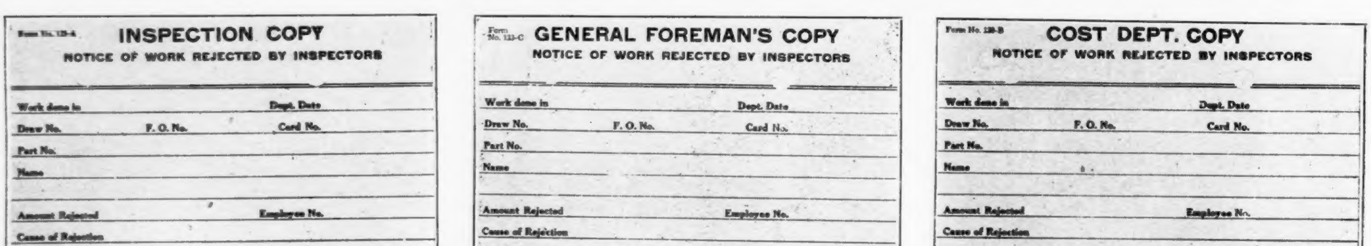

Form No. 281-1-09-5M.
SCRAP MATERIAL.
Draw. No.......... Fo. No..........
Card No.......... Emp. No..........
Article..........
Cause of Rejection..........
....
Date.......... Inspector..........

Fig. 30. "Scrap Material" Tag which is attached to Defective Work

ground of inadequate working of the patent in the United Kingdom. It appears that the company manufactured about 1,300 lamps in England, but that a license had been granted a German concern to import the patented article in Great Britain, for which privilege the German company paid the


INSPECTION COPY
NOTICE OF WORK REJECTED BY INSPECTORS
Work done in — Dept. Date
Draw No. — F. O. No. — Card No.
Part No.
Name
Amount Rejected — Employee No.
Cause of Rejection
Inspector

GENERAL FOREMAN'S COPY
NOTICE OF WORK REJECTED BY INSPECTORS
Work done in — Dept. Date
Draw No. — F. O. No. — Card No.
Part No.
Name
Amount Rejected — Employee No.
Cause of Rejection
Inspector

COST DEPT. COPY
NOTICE OF WORK REJECTED BY INSPECTORS
Work done in — Dept. Date
Draw No. — F. O. No. — Card No.
Part No.
Name
Amount Rejected — Employee No.
Cause of Rejection
Inspector

Fig. 31. Duplicate Report Slips which are filled out when it is Necessary to reject Defective Work

differential and transmission gears are also tested by the fan method, as shown in Fig. 33, the mechanism being driven by an electric motor of measured rating; any friction beyond an allowed amount is at once detected.

Fig. 34 shows the neat way that small parts are stored in metal boxes in the stock room. Everything is plainly labeled and easily found.

A partial view of the big dining room where luncheon is served to the men, is shown in Fig. 35. In this room eight hundred workmen can be seated at once. The lunch is served family style; that is, everything is placed on the

British Westinghouse Co. a considerable royalty. As the number of lamps imported under this agreement was several times greater than the number manufactured in the United Kingdom, it was considered by the authorities that the patented article was not manufactured to an adequate extent, and the patent has been revoked and the patentee ordered to pay the applicant for the revocation $375 for costs. Thus, it seems, that manufacturers of patented articles outside of Great Britain run a risk of having their patents revoked if they do not manufacture practically the whole supply for the British demand in that country.

PROPER DESIGNING OF MILLING AND DRILLING FIXTURES AND JIGS*

R. B. LITTLE†

In the designing of milling and drilling fixtures and jigs, I find from experience that there is always a chance of the designer overlooking some important point that is vital to the proper working of the jig or fixture. After observing these points for a long time and noting each one carefully, I have compiled them into a set of sheets carefully arranged, and we find them one of our greatest helps in this work. Each member of our drafting department is given a set of the sheets and is required to answer in his own mind each question given as he proceeds with the design of the fixture.

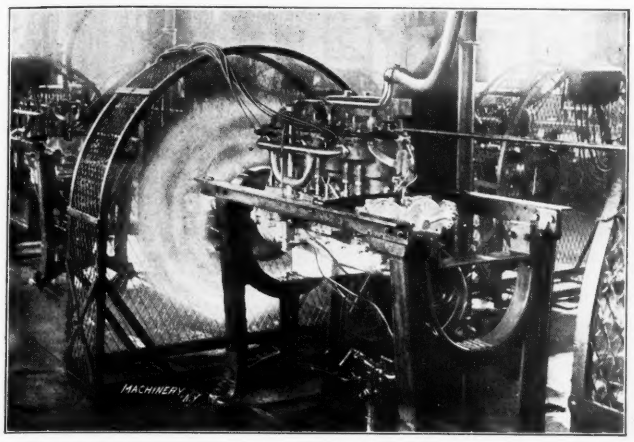


Fig. 32. Motor-testing Department—Each Engine is directly connected to a Fan which it drives for a period of 70 hours

Accompanying the catechism on the design of jigs and fixtures is one for checking drawings which we believe is especially good. It is believed that every point is touched on in proper order. These helps will be found particularly valuable to the chief of the tool-designing department. It will relieve him of much of the checking of drawings and the small details of work, allowing him to put forth more and better efforts in a more profitable direction.

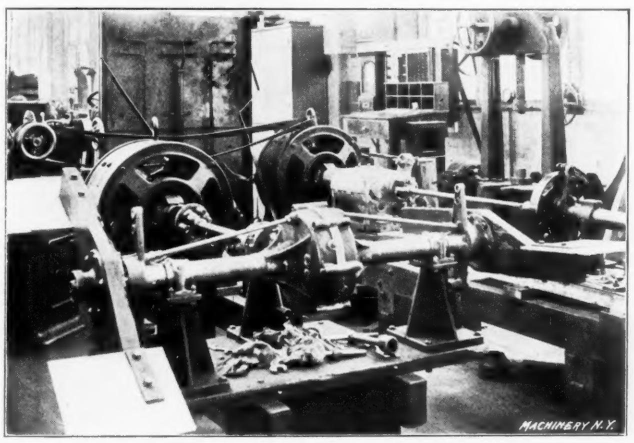


Fig. 33. Testing the Differential and Transmission Gears

Things to be Considered before Designing

1.—Does the part you are working on need a special fixture?

2.—What degree of accuracy is required in the work? Is it necessary that the drilled or milled pieces be intechangeable?

3.—Are there enough pieces to be machined, and will the accuracy of the work or the time gained warrant making the fixture?

4.—If it takes longer to mill or drill the part with a fixture than without it, will the accuracy of the work when done with the fixture compensate for the loss of time?

5.—Will any time be saved if the fixture is designed so as to do a number of pieces at each setting?

6.—Can the fixture be designed so that the operator can be replacing parts already done while others are being done?

7.—In drill jigs, if the holes to be drilled differ greatly in size, will it pay to make two jigs rather than put two largely different sized holes in the one? Have you range of speed or capacity varying enough to drill the two largely different sized holes on any one drill press?

After Designing Milling or Drilling Fixtures

1.—Considering the job, is the fixture too expensive to build?

2.—Will the fixture be a money-saver? Can you do more pieces and do them better with the fixture than without it?

3.—Will the expense of building the fixture be greater or less than that of the employes' extra time required to do the work without the fixture, and do it as well?

4.—What arrangement for holding the part in place in the fixture? Is it the simplest and quickest to operate, both in putting in the part and removing it, of anything you can design without sacrificing effectiveness?

Fig. 34. View of the Stock-room, showing the Neat Arrangement of the Metal Boxes which hold Small Parts

5.—What arrangement for taking care of milling and drilling chips? Can the chips be easily and quickly cleaned away?

6.—Has the fixture any bad places to collect grease and dirt? Any non-get-at-able places that will require cleaning?

7.—Has the fixture any weak points that may be strengthened? Are any of the parts a great deal stronger or heavier than necessary?

8.—Is the fixture too heavy and awkward to handle?

9.—Is there anything to hinder getting oil or compound on the work?

10.—If a pattern is to be made, are there fillets in all sharp corners where it is possible to put them? What arrangement for draft? Can the pattern be made so that it will come out of the sand? Are there any sharp corners to hold the sand in the pattern, or to break away in pouring?

Fig. 35. The Dining Room at the Works, which will accommodate 800 Workmen

11.—Is there anything about the make-up or operating of the fixture to endanger life or limb of the employe?

12.—Is the base of the fixture broad enough so that it has no tendency to tip over while the work is being done? Does the pressure of the work fall within the base?

13.—If the fixture will require oiling at any point, have you provided an oil hole?

* For additional information on this subject, see Jigs and Fixtures (first installment), April, 1908, and articles there referred to.
† Address: Oscar Lear Auto Co., Springfield, Ohio.

Drill Jigs

1.—How is the part located in the jig with regard to drill bushings? Is it located from the rough or from some previous operation?

2.—Does the jig need fastening down to the drill press bed? If so, what arrangement for same?

3.—If the jig is a small one and not to be fastened down, is there a handy place to hold it from turning with the drill?

4.—What takes the thrust of the drill?

5.—Does the point of drilling at any place fall outside the base of the jig?

6.—If the jig registers from hole to hole, what method of registering is used? Is it quick and simple to operate and is it positive and accurate?

7.—If any of the holes are to be tapped or reamed outside the jig, have you allowed for this in the sizes of the bushings?

8.—Are the bushings as close to the work as you can get them, and are they long enough to guide the drill through the hole?

9.—If the bushings are necessarily long are they relieved at top end to prevent chips from clogging around the drill?

10.—Is there a chance for the drill to run out without drilling a hole in the bed of the drill press?

Milling Fixtures

1.—Can the part be held more securely or the work done more accurately with a special milling fixture?

2.—Will the fixture save any time in doing the work?

3.—What takes the thrust of the cutter? Is it strong enough to take the thrust of the heaviest cut liable to be made?

4.—What arrangement for clamping the fixture to the platen of the milling machine?

5.—What arrangement for locating the part in the fixture in proper relation to the milling cutter? Located from the rough or from some previous operation?

6.—Is there a tongue on the bottom of the fixture for lining it up in the T-slot, and is it the proper width to fit the size of machine to be used on the job?

7.—If the fixture is a long one, is it strong enough to prevent buckling after the mill has passed over?

8.—Are there any projections which will bank the milling chips up in the way of the cutters?

9.—If the fixture has a dividing head or registering arrangement, what method is used? Is it accurate and positive?

10.—If the work is close to the arbor, have you allowed room for the arbor collars to pass over or by it?

11.—If you intend using a facing cutter, is the part supported at the proper places opposite the cutter so as to avoid the tendency of the work to spring away from the cutter?

12.—If formed or outline cutters are to be used, can they be ground without changing their forms?

To Check Your Own Drawing

1.—Have you given all dimensions necessary for the pattern-maker, the forge man, and the tool-maker?

2.—Drawing number on each sheet?

3.—Pattern symbol for each part that requires a pattern?

4.—The material and number required of each detailed part?

5.—The shop number of the fixture to be built or the order number under which it is built?

6.—The name of the fixture?

7.—The symbol of the part to be machined?

8.—The date?

9.—The proper note for every hole, whether drilled, tapped, reamed, bored, cored, or counterbored?

10.—Dimensions for the location of every hole and its depth and size?

11.—On all studs, pins, arbors, etc., the kind of fit required; whether sliding, running, wringing, loose, tight, tapping, drive or press?

12.—Over-all height, length, width, etc., of all parts? Will all sets of dimensions add up and produce the over-all dimensions given?

13.—The diameter and length or thickness of all round parts?

14.—All required finish marks?

15.—The kind and number of threads for all special taps or threaded pieces

16.—Will all the parts fit together as you intend them to, if the tool-maker follows your figures?

17.—Are all your threads shown long enough so that all nuts will come down to place?

18.—Notes for all parts you wish hardened, ground, etc.?

19.—Does your layout show plainly how to assemble the fixture you are building?

20.—Have you given finished faces for the tool-maker to lay out his work from, and have you given the location of all important holes, slots, bosses, tongues, grooves, etc., from these finished faces?

21.—Have you given all the views necessary for each part to make its every detail plain and readable to the maker?

22.—Have you given all necessary notes such as knurl, flat, rough-finish, finish all over, and your authority for all gages quoted, whether B. & S., Stubbs, U. S. Std., etc.?

23.—In laying out circles of holes, have you given the chord from hole to hole?

24.—Notes for all coil springs including size, and whether compressed or extended?

25.—Have you figured your tapers accurately?

26.—Can you do anything to your drawing to improve its appearance?

27.—Is there any way you can show your idea more plainly to the shop man? Can you make your drawing more readable?

28.—Will the fixture you have designed work as well when made as it appears to work on paper.

* * *

THE VALUE OF AN EFFICIENT ACCOUNTING SYSTEM

In an address, "Changing Industrial Conditions," delivered by James Logan, mayor of Worcester, Mass., at the Commencement of the Worcester Polytechnic Institute, June 11th, 1908, strong emphasis was put on the need for efficient accounting systems in manufacturing enterprises. He said that an accounting system is as real an invention and that it marks an advance in industry as great as many mechanical inventions. It was his opinion that cost analysis in some lines of industry has done as much to reduce the cost of production during the past five years as have the mechanical inventions made during the same period. Yet there are manufacturers who spend money lavishly, whose scrap heap for old machinery represents not one, but several fortunes, who are conducting their accounting by as crude methods as those which were in vogue when the stage coach represented rapid transit. These manufacturers have thrown into the scrap heap millions of dollars' worth of machinery which was not worn out and which still had in it years of efficiency, but because they were without definite knowledge of what it cost to operate the old machines, they had been persuaded to throw them into the scrap heap, taking estimated costs of the operation of new machines—estimates which are always stated in minimum figures, and which are almost never correct. As an example in point, Mr. Logan further said:

"I have in mind a series of envelope machines, which with the patents cost approximately $40,000, which could make and print envelopes at one operation for practically nothing if you simply figured the wages of the girl who sat before the machine. But no allowance was made for the fact that, in actual operation of these complicated machines, high-priced mechanics had to stand over them all the time with a monkey-wrench and screw-driver to keep them running. When this cost as well as repairs and interest on the extra investment were considered, the older machine, which made less waste, required less supervision, and stood a smaller interest charge, distanced in the race the new, improved, automatic, fast-running machine, and it has gone to the junk heap and the machines running before this machine was invented and installed in the same factory are still doing good work and at a lower cost (when all the costs were figured in) than the new machine ever did. The point I want to make is this: if there had been a knowledge of the actual costs of operation of the old machines, a comparison of those costs would have developed the fact that the new machine was not a good investment and its purchase would never have been considered."

ANVILS AND FORGES*

JAMES CRAN†

The anvil and the forge are the two most important appliances of the blacksmith shop. Anvils are made in various shapes to suit different classes of work, but for all around work, and particularly for machine blacksmithing, no anvil gives better service than the standard pattern of solid wrought iron provided with steel face. This class of anvil is practically the only appliance used by the blacksmith that has been standardized. In general, it may be said that the anvil appears to have been developed along intelligent lines, and standard anvils are generally satsfactory with the exception that the square hole for the tool shanks is seldom straight or of exactly the same size in any two anvils of the same make and weight. This difficulty might be overcome by broaching the

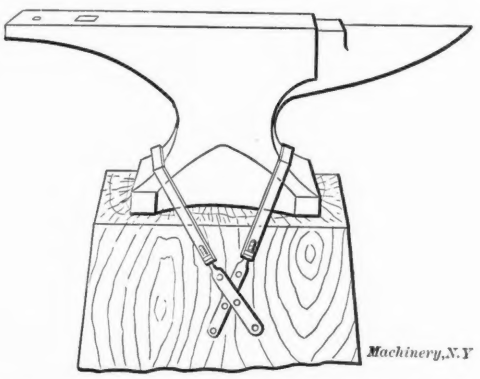


Fig. 1. Objectionable Manner of Holding an Anvil in Position

hole before the face is hardened. With this improvement, tools made to fit one anvil could be used elsewhere without danger of breaking the shank.

The quality of an anvil can generally be judged by its "ring," a good anvil giving out a sharp, clear sound when struck with a hammer; if soft or not free from flaws, the sound will be dull. A good anvil mounted on a block in such a manner that it gives out its full volume of sound is easier to work upon than one where the ring is deadened. There is a great deal of difference of opinion as to how anvils should be mounted, the general idea apparently being that it should be strapped fast to the block on which it is placed. If this were necessary, it is likely that the makers of anvils would have provided them with lugs or slots suitable for fastening them to the support.

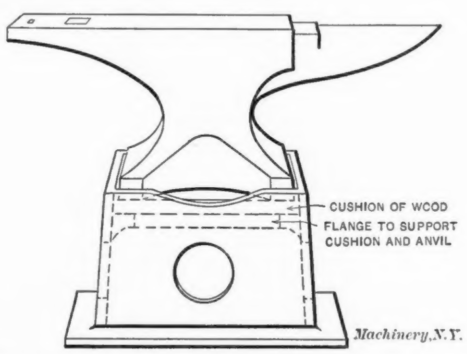


Fig. 2. Correct Form of Anvil Block, and Proper Method of Mounting Anvil.

When a wooden block is used under the anvil, it is necessary to use a few spikes to keep the anvil in place, but these should be placed around the base in such a way that they do not bear directly upon it or pinch the corners. A common but poor way of holding an anvil in position is shown in Fig. 1. This method checks the vibration which tends to keep the face free from scales, and it renders a high-grade wrought iron anvil little better than if it were made from cast iron.

A mistake often made is the selecting of anvils too light for the work to be done. This may be done from a mistaken idea of economy, but light anvils do not give as good service or last as long as heavier ones. The 300-pound anvil is suitable for nearly any kind of machine blacksmithing, and if of this weight or heavier it will not move around when used, or need to be strapped to its block.

Wooden blocks must be sunk to a certain depth in the floor in order to keep them in place, and their height may have to be adjusted from time to time to suit a short or tall blacksmith. Cast iron mounting blocks are therefore preferable. An anvil mounted upon a block by a proper method is shown in Fig. 2. The block is made of cast iron, hollow in the center, with a flange 1½ inch wide by 1¼ inch thick, having a heavy fillet on the lower side where it joins the body of the block. On the inside, 2½ inches from the top, a piece of wood about 1½ inch thick and of the same size as the top of the block inside, is placed. This forms a cushion for the anvil to rest on. The top edges of the block in the back and front are made lower in the center than at the ends, permitting the scale and dirt from the work to find its way to the floor instead of getting under the anvil. A flange 3 inches wide all around the outside forms the base of the block and gives it a solid bearing on the floor. The location of an anvil mounted on this type of block can be changed at any time, and its height can be adjusted without much trouble. The wooden cushion gives a block of this kind all the advantages and none of the disadvantages of a wooden block.

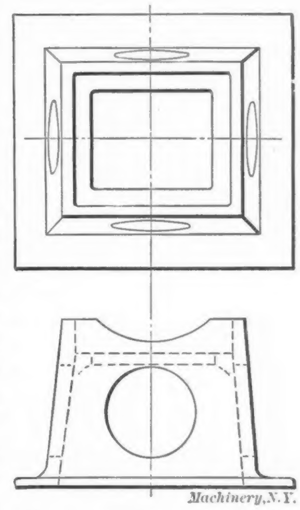


Fig. 3. Cast Iron Anvil Block

In Fig. 3 the cast iron anvil block is shown in detail. It should be so adjusted when an anvil is placed upon it that the

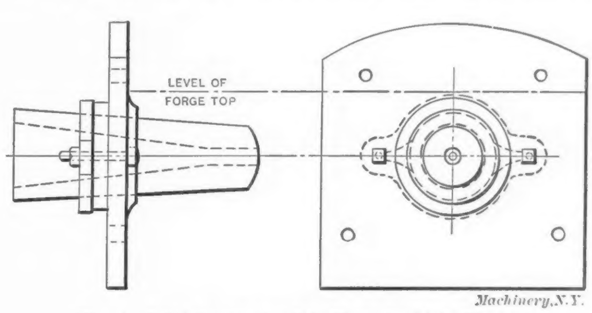


Fig. 4. Solid Tuyere for Side Blast for Light Work

face of the anvil will be inclined at an angle of about 3 degrees towards the front. This not only makes the work easier for the blacksmith, but gives the scales a tendency to leave the face of the anvil on the side furthest from him.

Large pieces of hot metal should never be left on an anvil longer than absolutely necessary, and in no case should hot work be left on the face of the anvil when the blacksmith leaves his work. If this is done, it will affect the temper and soften the face.

The Forge

The forge has been developed along somewhat less successful lines than the anvil. Different makers have turned out various types, if not a little better, at least a little different from their competitor's. There is scarcely a forge on the market which does not have the opening or openings of the tuyere at the lowest point of the fire pan, which is the place where clinkers and slag collect, and the opening of the tuyere gets filled up if not constantly cleaned out. To overcome this evil, some forges have a shaker, which in turn has brought about the enlarging of the opening of the tuyere to accommodate the shaker. This not only has a tendency to spread the fire, making it almost impossible to take short heats, but clinkers and slag are worked through the tuyere into the air chamber or wind box until the blast is obstructed. The aim of the practical blacksmith is to have the forge and fire in such

* For previous articles on blacksmithing and blacksmith shop practice see: "System for the Blacksmith Shop," August, 1908; "Tools for the Blacksmith Shop," September, 1908; "The Steam Hammer and its Use," October. 1908; "Tools for Increased Production in the Blacksmith Shop," November, 1908; "Welding," December, 1908; "Notes on the Economical Working of the Blacksmith Shop," March, 1909; and "The Forging of Hooks and Chain," April, 1909.

† Address: 916 West Third St., Plainfield, N. J.

condition that he can concentrate the heat at some given point of his work when required. The lack of a suitable forge for this purpose on the market accounts for so many forges of the home-made variety being used. The home-made forge is usually very crude looking, but it serves its purpose. The material used for the top of the forge may be either stone, brick or a piece of the shell of an old steam boiler or tank, or even a wooden frame forge with sand up to the level of the tuyere. The writer has seen a very serviceable forge made from one-half of a large barrel. This was used for heating work up to five inches in diameter. This, of course, does not mean that wooden forges are recommended.

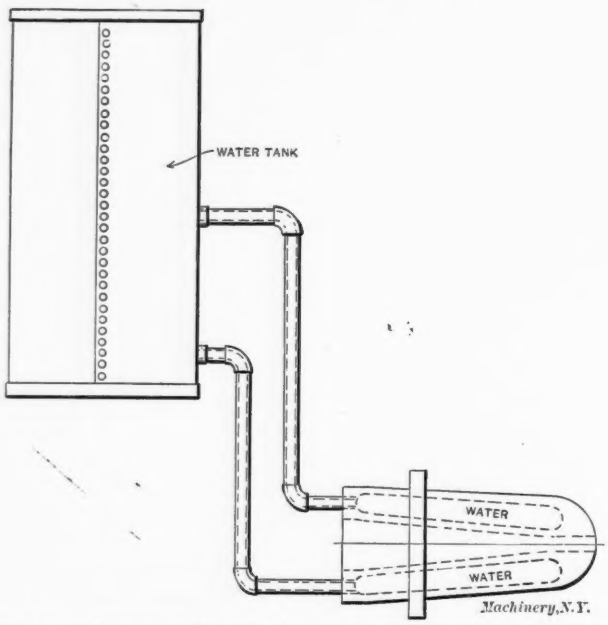


Fig. 5. Water-cooled Side Blast Tuyere for Medium and Heavy Work

The most important features on a forge are the method of conducting the blast from the blower to the fire and a simple and effective means of getting rid of the smoke. In conducting the blast to the fire it must pass through the tuyere. There are two distinct types of tuyere, one with side, and one with bottom blast, either of which will give good service if properly constructed. The side tuyere, although little used in this country, is extensively used throughout Europe, and is preferable to the bottom tuyere for some classes of work, particularly when heating to an even temperature on all sides when the shape of the work does not permit it to be turned in the fire. The work is then placed in the fire on the level of the opening of the tuyere and the fire is so arranged that the blast circulates freely over and under the work. A solid side tuyere with breast-plate is shown in Fig. 4. The shape is circular and slightly tapered, with a collar at about one-

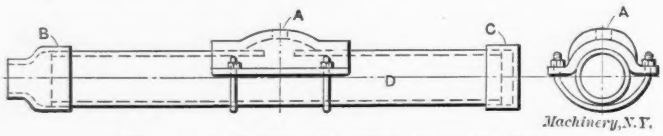


Fig. 6. Air Chamber and Tuyere for Bottom Blast

third of the entire length from the large end. The inside is hollow and tapers as shown. When placed in position in the breast-plate, the tuyere is forced as far through as the collar will permit, and is held in position by a yoke placed behind the collar. Two bolts connect the yoke with the breast-plate, which in turn is attached to the left-hand side of the forge by bolts. This tuyere is used for light forging.

For medium and heavy work a tuyere as shown in Fig. 5 is generally used. The principle of construction is the same as in Fig. 4, but it consists of an outer and inner shell, the space between which is filled with water to keep the metal from being overheated. The water is supplied from a tank, to which it returns after it has passed through the tuyere. Sometimes tuyeres of this style are directly connected with a water tank without the use of pipes.

A simple and inexpensive but very efficient form of air chamber and tuyere for bottom blast is shown in Fig. 6. The air chamber *D* is made from a piece of wrought-iron pipe at least 4 inches inside diameter. On the end projecting through the left-hand side of the forge a reducing coupling *B* is placed so that a pipe of 2½ to 3 inches in diameter can be used to connect it with the air supply. On the other end, which projects on the right-hand side of the forge, a metal cap *C* is used, which closes this end. This cap can be unscrewed at any time for cleaning the air chamber. The tuyere *A* can either be made of cast iron or forged from wrought-iron and is held in position by two U-shaped bolts. Some fire clay or asbestos soaked in water placed between the tuyere and the air chamber provides an air-tight joint when the bolts are tightened. When making a tuyere of this kind it is important that it be spherical or conical in the center and that the blast opening be at the highest point. Clinkers and slag will then collect at the base instead of directly over the opening. With a tuyere made in this way no shaker or other device is required to keep the opening clear. The air chamber is made larger than the pipe supplying the blast in order that a full air supply may pass through even when a small quantity of clinkers or slag have accumulated under the tuyere.

An air chamber and tuyere of somewhat improved design is shown in Fig. 7. The air chamber is cylindrical with a circular opening at the top into which the tuyere fits. A small opening at the left near the top of the air chamber provides

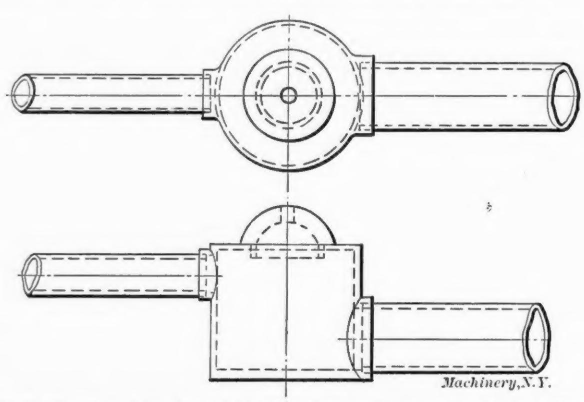


Fig. 7. Improved Design of Air Chamber and Tuyere for Bottom Blast

an inlet for the blast, and a larger pipe to the right provides means for cleaning. No bolts or other appliances are necessary to keep the tuyere in place, fire clay or asbestos placed under the flange making it air-tight and holding it in position.

In shops where the range of work is large and the number of forges is limited, tuyeres with different sizes of openings can be used in the same forges for different classes of work when made as outlined. For heavy work, a low tuyere with a large opening should be used, and enough fuel should be kept between the blast and the work to consume the oxygen before it reaches the work. For light work a high tuyere with a small opening is used, because it saves fuel and tends to keep the fire in a small space.

For machine blacksmithing forges should be from 36 to 42 inches in diameter and from 26 to 30 inches high, the top of

TABLE OF SIZES AND ARRANGEMENTS OF TUYERES

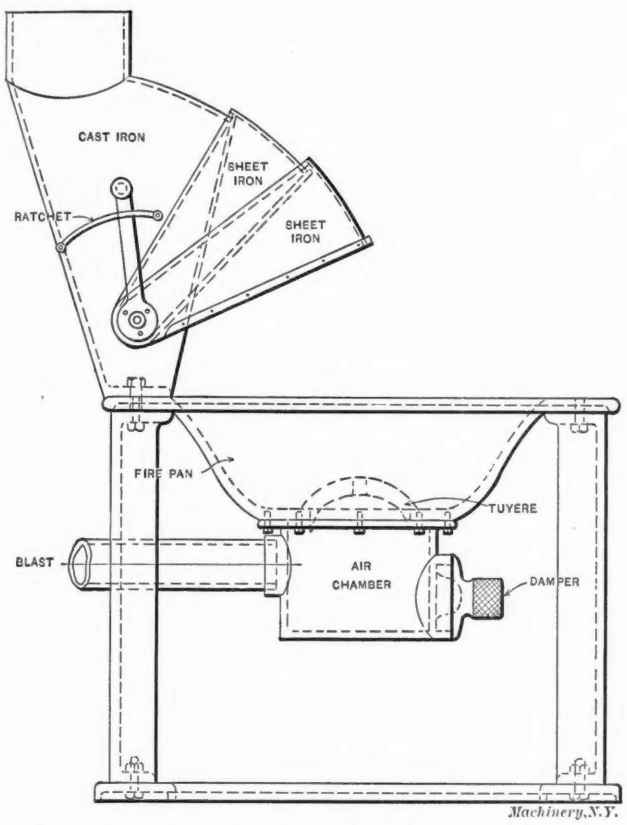
	Inch.	Inch.	Inch.	Inch.	Inch.
Size of opening in tuyere	¾	1	1⅜	1¾	2
Distance between top of tuyere and top of forge	4	5	6	7	8
Size of supply pipe.	1¾	2	2½	3	3½
Size of work to be done	¼ to 1	1 to 2	2 to 4	4 to 7	7 to 10

the tuyere being from 4½ to 7 inches lower than the top of the forge. As there are no standards or definite data for guidance in determining the size of the opening for tuyeres or the depth at which they should be placed below the level of the hearth, the accompanying table gives what the writer considers to be proper dimensions for work varying from ¼ inch to 10 inches diameter, when the blast is delivered

at a pressure of eight ounces per square inch or over. Work over 10 inches in diameter can be more uniformly and economically heated in a furnace.

Carrying off the Smoke from the Forge

The smoke is generally carried off with more or less success by means of a bell-shaped hood suspended over the forge and connected with the chimney. Without exception the bell hood is the worst form to use, as more smoke and gas is admitted at its base than the chimney is capable of carrying off, and the smoke spreads through the shop and escapes by doors or windows after having made conditions uncomfortable for the blacksmiths. Forges without hoods are preferable to the bell hood, provided there are means for ventilation in the roof of the shop, as then the gases can rise freely and escape. Another objection to the bell hood is that it prevents a crane from being used to any advantage over the forge. In order to overcome the drawbacks mentioned some concerns have installed the down draft system in their blacksmith shop. This system has its advantages; no overhead pipes, smoke or gas have to be contended with and the equipment is ideal for training schools and similar places, but for the practical blacksmith shop, where the cost is an item



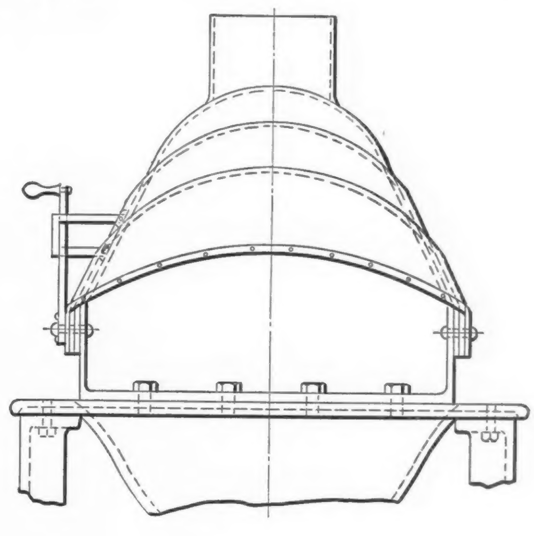


Fig. 8. Skeleton Forge with Cast Iron Hood Frame and Adjustable Sheet Iron Folding Hood

of first importance, it presents disadvantages; it is designed to work in direct opposition to the laws of gravity, and the amount of power necessary to create enough suction to draw the smoke and gases down is too great.

A forge and hood, which give good service both for heating work and for carrying off the smoke when individual chimneys are used for each forge, or when connected with a draft system, is shown in Fig. 8. The body of the forge is of cast iron and constructed on the skeleton plan. This allows of tools or other appliances too large for the tool bench to be kept under the forge. The tuyere and air chamber are practically the same as shown in Fig. 7. The main part of the hood is of cast iron and is placed on the left-hand side of the forge where it is held in position by bolts. The chimney is placed to the left as shown and out of line with the top of the forge, and therefore permits of a crane being brought directly over the fire and the work. The adjustable parts of the hood are made of sheet metal, reinforced at the edges with band iron and joined near the base so that they can be let down close to the forge when a new fire is being built, or folded back to the base of the chimney, leaving the whole top of the forge clear when required. The chimney should never be less than 8 inches inside diameter. The forge here shown was designed several years ago and has been in use continually and has given satisfaction on all kinds of machine blacksmithing from ¼ inch to 10 inches in diameter.

* * *

An amusing instance of the peculiar foolishness cherished by some manufacturers in regard to so-called "trade secrets" came to our attention a few months ago. A demonstrator and trouble-man, working for a prominent Western machine tool builder, some years ago visited a small concern in the East which had developed a new process of making—well, let us say gimlets, as that is about as near as we can approach the name without telling what the product really is. The process and gimlet were patented and the inventor had no hesitation in showing the process in its entirety to the interested mechanic. In the course of a year or so the gimlet and process were sold to a competing concern noted for its conservatism and fear that any process carried on within its walls would become known to the prying world outside. Our friend having business with the concern in connection with the machines he represented asked the privilege of inspecting its methods of making gimlets and was turned down flat for the reason (?) that a new process had recently been produced which was a valuable trade secret and under no circumstances could he or any other outsider be permitted to see it. A few questions elicited the fact that the secret process was the one our friend had seen in its entirety a year or so before.

It will be noted that we said our friend asked the *privilege* of seeing the methods of manufacture. It is indeed a great privilege we enjoy generally in the United States of being admitted into manufacturing plants and seeing the principal manufacturing methods in which we are legitimately interested. If a manufacturer does not care to grant this privilege to every one he is entirely within his rights. The time and trouble of escorting visitors through a large plant is often a serious tax on the time of men capable of explaining the processes intelligently, and if the advertising that results is not appreciated or desired, the manufacturer is under no obligation to follow the general custom, but if he does not care to follow it he should not take refuge in the threadbare excuse that the privilege is denied because of the existence of trade secrets. This plea brands him as unprogressive and out-of-date, when as a matter of fact, he may be neither.

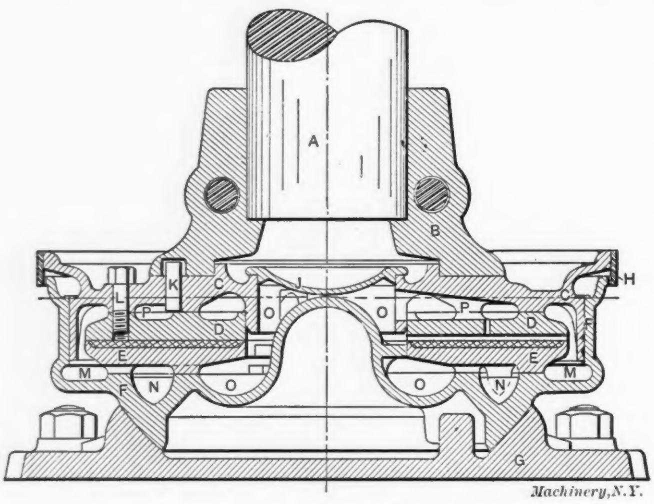
* * *

It is stated in the *Mechanical Engineer* that a British firm, the Hadfield's Steel Foundry Co., has for a long time been experimenting in order to ascertain whether it be possible to cast armor plates. The experiments appear to have been successful, and the company now supplies some parts of armor made by a casting process.

EXAMPLE OF STEP BEARING DESIGN

The thrust or step bearing is a difficult proposition at its best. When heavy service is required of it, the engineer meets with three inherent difficulties in design. These difficulties are: first, insufficient bearing surface; second, difficulty of lubrication; and third, uneven wear of thrust surfaces. In the case of important bearings, such as those for taking the thrust of the propeller on a steamship, multiple thrust collars are used, which obviate the first difficulty; forms of forced lubrication are employed, to avoid trouble from the second cause; and the bearing collars are made comparatively narrow, and enough of them used to give the required area, to avoid the trouble from uneven wear. This, of course, necessitates careful adjustment of the different bearings, so that each has its proper share of the load.

For installations which do not work under quite such severe strain, and on which there is not so much depending as in steamship service, it is common to provide the thrust bearing with a number of washers between the revolving shoulder of the shaft and the seat of the bearing. This does not add to the effective bearing area but does decrease the troubles arising from insufficient lubrication and uneven wear, as a multiplicity of bearing surfaces are provided, one of which automatically goes into action when another commences to run hard from any cause. The surfaces thus take turns with each other as need arises. The question of lubrication is generally settled by causing the rings to revolve in a bath of oil. If the grooves are properly placed, this is sufficient for ordinary purposes.



A Submerged Step Bearing for Heavy Service.

The bearing shown in section herewith works under particularly difficult conditions in that it is heavily loaded, runs in an atmosphere charged with gritty dust, and is liable to neglect. The service for which it is used is too rough for the first method of design described above, and too heavy for the second. It is used for supporting the heavy revolving grinding pans, which are used to crush and temper the raw material in clay working industries. The grinder wheels of these pans weigh 5 or 6 tons, not to mention the weight of the clay and the pan itself. There is the further strain of the shock resulting when the heavy grinder wheels roll over large lumps of clay and fall back to the pan again. This constant jar requires a bearing of the simplest construction, without delicate adjustments. The design shown herewith has been in use for a number of years under these severe conditions and has given excellent satisfaction.

As may be seen, a single set of surfaces is used, the bearing taking place between plates *D* and *E*. The upper plate, which is the revolving member, is of close-grained cast iron. It rests on seats formed in the plug *C*, and is caused to revolve with it by means of screws *L* and dowels *K*. The lower plate is a cast iron shell with its wearing surface filled with "Fahrig metal." It rests on finished seats in the bowl *F*, where it is held in a central position and prevented from rotating by lugs which interlock with others on the bowl. This latter member rests in a spherical seat in the base-plate *G*, so that any irregularities in the alignment of the foundation and shaft are overcome, and any changes of position which may occur are automatically taken care of without springing of the working parts. Interlocking lugs on both the base-plate and the bowl prevent the latter from revolving.

The bowl *F* is, as its name indicates, a receptacle for the lubricant, which rises to the level of the dotted line shown. The plug *C* is finished on its periphery, where it forms a bearing surface with the bowl, while it carries a rim *H*, which extends upward and outward over the bowl, forming an apron which prevents access of dust to the lubricant through the only possible entrance. The circulation of oil is effected by staggered channels in the wearing face of *E*, in combination with circulation grooves in face of the upper plate *D*. When the bearing starts to revolve, the construction of these grooves draws the oil through from inner reservoir *O* to the outer or supply chamber *P*. This movement is assisted by centrifugal force in the upper chambers *O*, which force the oil to pass down through the holes in the plug *C* into the grooves in the plate. This movement of the oil results in an increased head or pressure in the outer chamber *P*, and a corresponding decrease of head in the inner chamber *O*. Since the lower part of the oil body in the outer section is at rest, it is not under the influence of centrifugal force, though under the excess of pressure caused by that part of the oil that is in motion, a return movement is set up toward the central chamber through passages *N*. These return channels are staggered so as to make the path as long as possible. The current passes over ribs which act as riffles to allow the particles of metal in the oil to settle. On account of this construction the oil furnished to the rubbing surfaces is always the purest oil in the bearing.

This apparatus is very compact, it being but 8 inches from the end of the shaft to the foundation. After the split coupling *B* has been removed, it will be seen that there is enough space between the shaft and the top of the step to allow the latter to be removed from the base plate as a unit. This feature is of value in the gritty atmosphere in which the bearing is installed, since it may be removed to a clean place, where it is wiped out, assembled and filled with oil. It is then returned in its assembled condition, so that dirt and dust do not get into it. The oil is poured in through the opening closed by the cover *J*. Enough is poured in to just cover the top of the rounded boss projecting up in the center of this compartment.

It will be seen that in this bearing the requisite area has been obtained by making the rubbing surface of large diameter. To do this and keep the surfaces in good condition, requires that they shall be so supported that the deflections of the metal under the dead weight and under the shock will not cause portions of the bearing surfaces to break through the oil film. The construction is worthy of study from this standpoint. The circulation of oil provided is so thorough as to increase the efficiency of the bearing surface, reducing the area below what would be necessary with the ordinary "squirt can" method of lubrication, with the inefficiency and uncertainty always attendant on it.

The first of these bearings was installed in the Akron Fire Brick Co., 1901, where it has been running ever since without any expenditure for repairs and renewals, aside from breakage due to an accident for which the bearing was in no way responsible. It has been oiled in this service in periods varying from six to fifteen months apart, without giving the slightest difficulty. The grinding pans of the Windsor Brick Co. have also been equipped with the same bearing. They are refilled every six months, though the oil is found to be in good condition at the end of that time. The illustration shows a more recent design, intended to carry a 12-ton load, in which the wear plates are 15 inches in diameter.

An interesting point relating to the efficiency of the device is its saving in oil. The ordinary bearing for this use, which is from 4½ to 5 inches in diameter, running on hardened steel and bronze washers, requires on the average about 6 gallons per year on each bearing, as supplied with a squirt can, and even with this large amount there is rapid wear and constant

trouble. The use of the self-oiling feature is in line with an editorial on the subject published in the July, 1908, issue of MACHINERY. Whatever may be said against the use of this principle under other conditions, it is obviously correct practice for the vertical step bearing, working under severe duty. The designer of this bearing is Edward F. Edgecombe of the Edgecombe Co., Cuyahoga Falls, O.

* * *

COULANGE SYSTEM OF AUTOMATIC INDEXING

The dividing apparatus illustrated herewith, which was recently described in the *L'Alliance Industrielle*, is designed to index work automatically. It requires no more room on the milling machine table than the ordinary universal dividing head, and consequently the distance between the centers is not lessened. Both straight and helical cuts may be taken, with the spindle set to any angle from 0 to 90 degrees, and the work automatically indexed either 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15, 18, 20, 21, 24, 28, 30, 36, 42, 60, or 84 divisions, by the use of four plates *C* and five counters *O*. It is possible to obtain other automatic divisions by changing the plates *C* and *O*, and multiples of these automatic divisions may also be obtained semi-automatically. This dividing head has, in addition, all the advantages of the usual form of hand dividing apparatus, such as that used for gears, etc., as it is possible to obtain from 0 to 380 indexings, comprising the prime numbers; and also to obtain all these numbers (except the prime numbers) on helical cuts with the spindle set at any angle from 0 to 90 degrees.

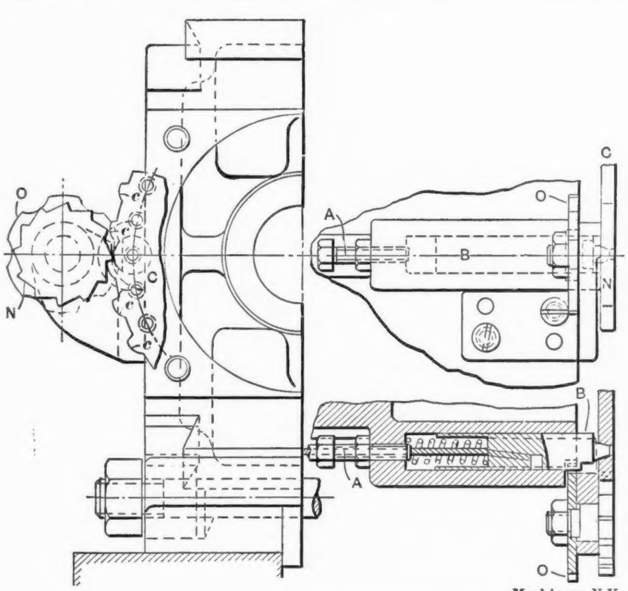


Fig. 2. Detail showing the Locking Mechanism and Plates which control its Movement

The apparatus comprises a differential combining the movement of the dividing plate *C* with the usual dividing plate *P*. This differential includes the plate *C*, the hub *D*, and the bevel teeth formed on gears *E* and *S* which mesh with the planetary bevel pinions *T*, mounted by the pivot *U* on the support *V* which is in two pieces and is keyed to the spindle *G* of the head. In addition, there is an automatic controlling mechanism for the indexing, which includes a spindle *L* driven by a coupling *W*, connected with a special pulley carried in a bracket on the bed of the milling machine; clutch *M* fixed on spindle *L*, and a worm *K*, which is free to revolve on this spindle and which is pressed against the clutch *M* by a spring *H*, rod *I* and finger *J*, when the gear *E* is free to revolve which takes place when the locking bolt *B* (Fig. 2) is withdrawn from the plate *C*. This locking bolt has a spring and Bowden cable which actuate it, the tension of the latter being regulated by screw *A*. The distance which the plate *C* moves at each indexing is controlled by a hole counter composed of the toothed dividing plate *C*. a toothed disk *N* and a stop-plate *O*.

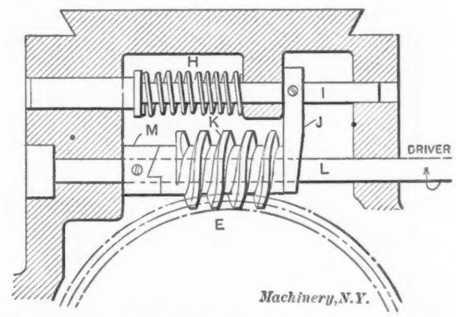


Fig. 3. Detail of the Mechanism which indexes the Work when the Locking Bolt is withdrawn and the Gear E is Free to revolve

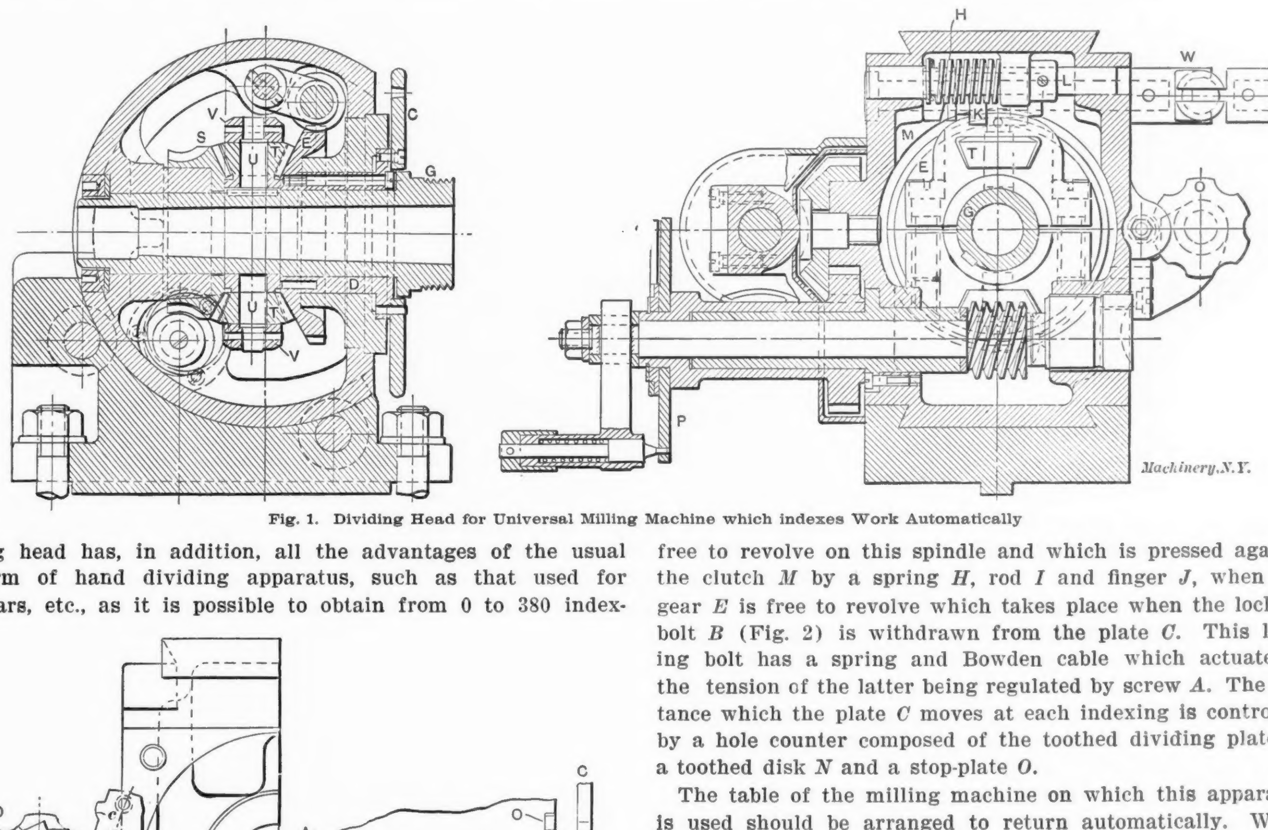


Fig. 1. Dividing Head for Universal Milling Machine which indexes Work Automatically

The table of the milling machine on which this apparatus is used should be arranged to return automatically. When the cutter has made its first cut, the table returns, and when it is about to finish this return stroke, a suitable mechanism gives a quick pull on the Bowden cable. This pull draws bolt *B* toward the rear, disengaging the dividing plate *C*. The hub *D*, the worm-wheel *E*, the differential and the spindle *G* of the apparatus are thus left free. The pressure of spring *H* gives these parts a gentle movement by the operation of *I*, *J* and the worm *K*. (See the detail Fig. 3.) This last member sliding freely on its spindle *L*, carries the clutch teeth, with which it is provided at one end, into contact with the teeth of the clutch *M* fixed on spindle *L*. Worm *K* thus receives a rotary movement from *M* which it transmits to the differential and to the dividing plate until bolt *B* enters one of the succeeding lock holes in the plate. The division is thus completed, and as the movement of the worm-wheel *E* is arrested, the screw in continuing its rotation is moved backwards, disengaging itself from the clutch *M* and stopping. The dividing plate *C* is provided with a number of teeth *c* (Fig. 2), the number corresponding to the number of its holes. Whenever this plate is set in motion, the first of these teeth strikes the toothed disk *N*.

which is thus made to turn the counter *O*. A solid portion of this counter is thus placed in front of bolt *B* which prevents the bolt from engaging with plate *C* until the required number of holes to bring the cut to the place designated by

Number of Holes in Dividing Plate C.	No Counter.	Number of Cuts in the Counter O.				
		6	4	3	2	1
12	24	12	8	6	4	2
18	36	18	12	9	6	3
30	60	30	20	15	10	5
42	84	42	28	21	14	7

the counter *O* have passed. The bolt *B* then engages with plate *C* and the division is accomplished. Plates *C*, *O* and *N* are thus furnished with holes and teeth, the number of which depends on the division it is desired to obtain. We show herewith a table of the plates employed to obtain the different automatic divisions mentioned in the foregoing.

* * *

THE TRIBULATIONS OF INVENTORS

One of the most difficult persons with whom the honest and fair-minded manufacturer has to deal is the inventor who presents to him an idea for the improvement of a mechanical device, but who lacks, utterly, the ability and the mechanical skill and knowledge to put his idea into a commercially acceptable form. Ofter the manufacturer receives from such an inventor nothing but a very crude idea, the working up of which into practical form must be done entirely at his own expense within his own factory. Under those circumstances it is clear that the manufacturer does not consider himself warranted to offer to the inventor a price for his invention equivalent to the value of the device when it has finally been put into practical working condition. But the inventor in most cases considers himself unfairly treated if his compensation is not based on the ultimate value of the device, and he forgets entirely that he did not himself make the invention commercially successful, but merely supplied a more or less crude idea, which, by itself, would have been valueless.

In fact, most inventions offered to manufacturers by inventors outside of their own shops are of this nature, and inventors should always consider before complaining about unfair treatment whether they themselves actually offered for sale a mechanically perfect and commercially successful device. If that is the case, the inventor is entitled to a full share in the proceeds. If, however, merely a crude idea is offered and the inventor is incapable of giving it mechanical perfection, then he has no just reason to complain if manufacturers do not appreciate his offer and refuse to pay an exorbitant price for something, the development of which still largely depends on their own resources.

When the inventor is employed in a manufacturing concern the question usually has a different aspect. He is then, as a rule, able to make his invention mechanically successful, and the full credit for both the original idea and the commercial application is often due to the inventor himself. Inventors of this class, however, have often more reason to complain than has the other class mentioned, for by reason of their employment they are practically forced to sell their invention to their employer at his own price, and the main compensation that they receive commonly consists merely in permanent employment at reasonable wages. This class of inventors, however, seldom complain, because present economic conditions has taught the majority of men to be content as long as they feel reasonably sure of permanent employment.

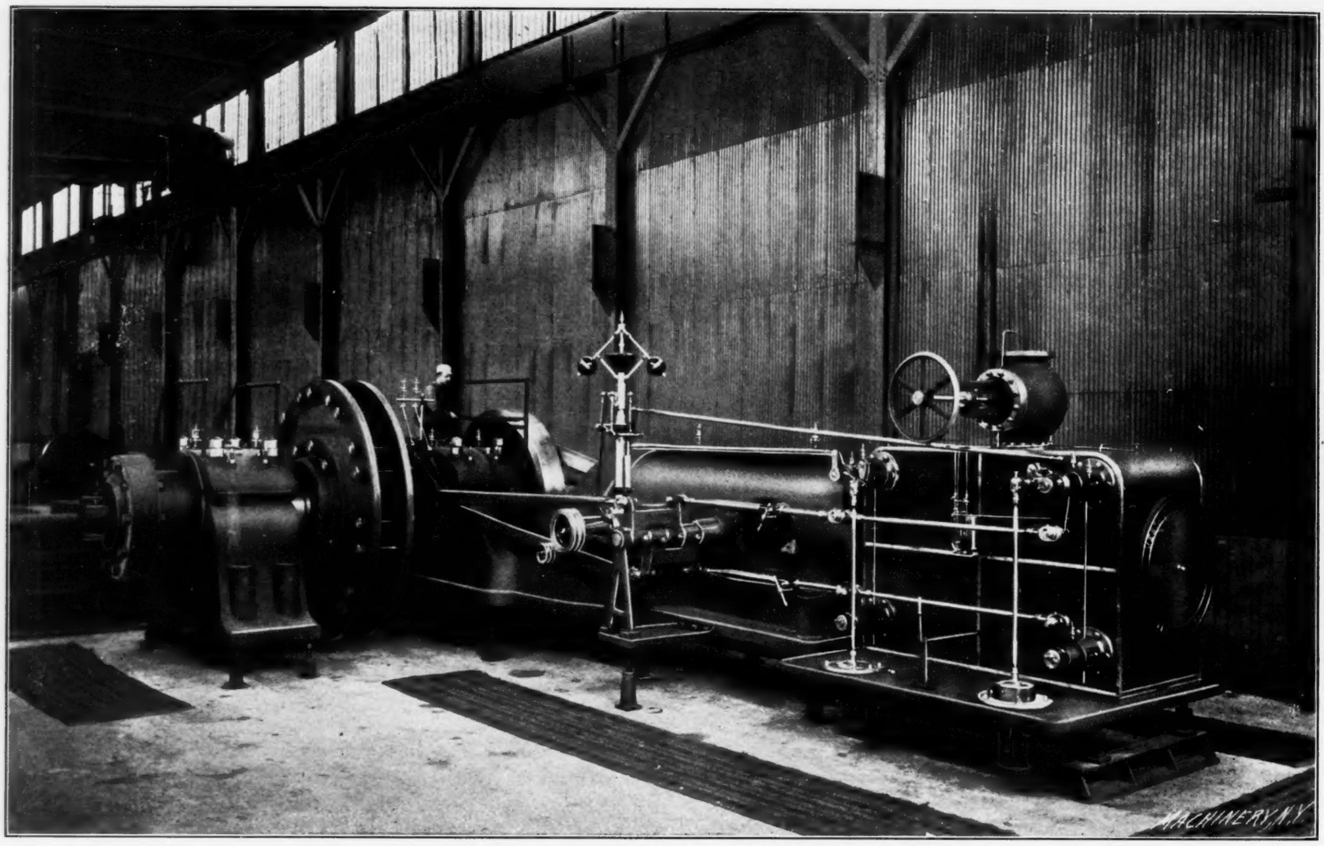


Fig. 1. Rolling Mill Engine built from "Pig Iron to 3500 H.P." in Thirty Days

* * *

BIG WORK OF THE MESTA MACHINE CO.

In a business note in the April number of MACHINERY, it was announced that the Engineers' Club of Western Pennsylvania and others made a trip to the works of the Mesta Machine Co., at West Homestead, near Pittsburg, to inspect interesting new machinery, and office, foundry and pattern storage buildings. A special train of nine cars was run from the Union station to the works on the Monongahela division of the Pennsylvania Railroad, and among the 650 visitors were many prominent manufacturers and engineers.

The illustration, Fig. 1, shows the Corliss rolling mill engine referred to, which was built from "pig iron to 3,500 horsepower" in thirty days. The engine completed weighs 400,000 pounds, of which 200,000 pounds are in the flywheel. It was built for the Phillips Steel & Tin Plate Co., Clarksburg, W. Va., and replaces an engine that was wrecked February 24. The old engine drove the twenty-eight-inch steel mill, and this department was at a complete standstill during the interval

required for building the new engine; hence the effort to replace it in record-breaking time.

The illustration, Fig. 2, is a long cross-head type, low-pressure blowing engine, standing on the erecting floor at the time of the inspection, which had just been completed for the Tennessee Coal, Iron and Railroad Co., Ensley, Ala. The steam cylinder of this engine is 84 inches diameter, air cylinders 84 inches and stroke 60 inches. Twenty-four blowing engines of the same type and size are now in operation at the furnaces of the Tennessee concern, all built by the Mesta Machine Co. The engine illustrated weighs about 250 tons.

Another feature of the machine shop that held the attention of the visitors was the machinery for a 600-ton metal mixer, the largest by 300 tons ever built. This new departure in size means that the resources of the engineer for meeting the demands made by the steel manufacturers of to-day are practically unlimited. In the roll foundry the visitors were shown the pouring of chilled rolls, both by the old methods, in use for many years, and the new water-chilled process of the Mesta Company. This operation is a revolution in the science of roll-making, as the positive control of the mechanical devices enables the operator to get exactly the depth and hardness of chill desired. In the new iron foundry, an engine frame weighing 160,000 pounds was poured from four huge ladles. This building is equipped with 100-ton traveling cranes for handling ladles and castings.

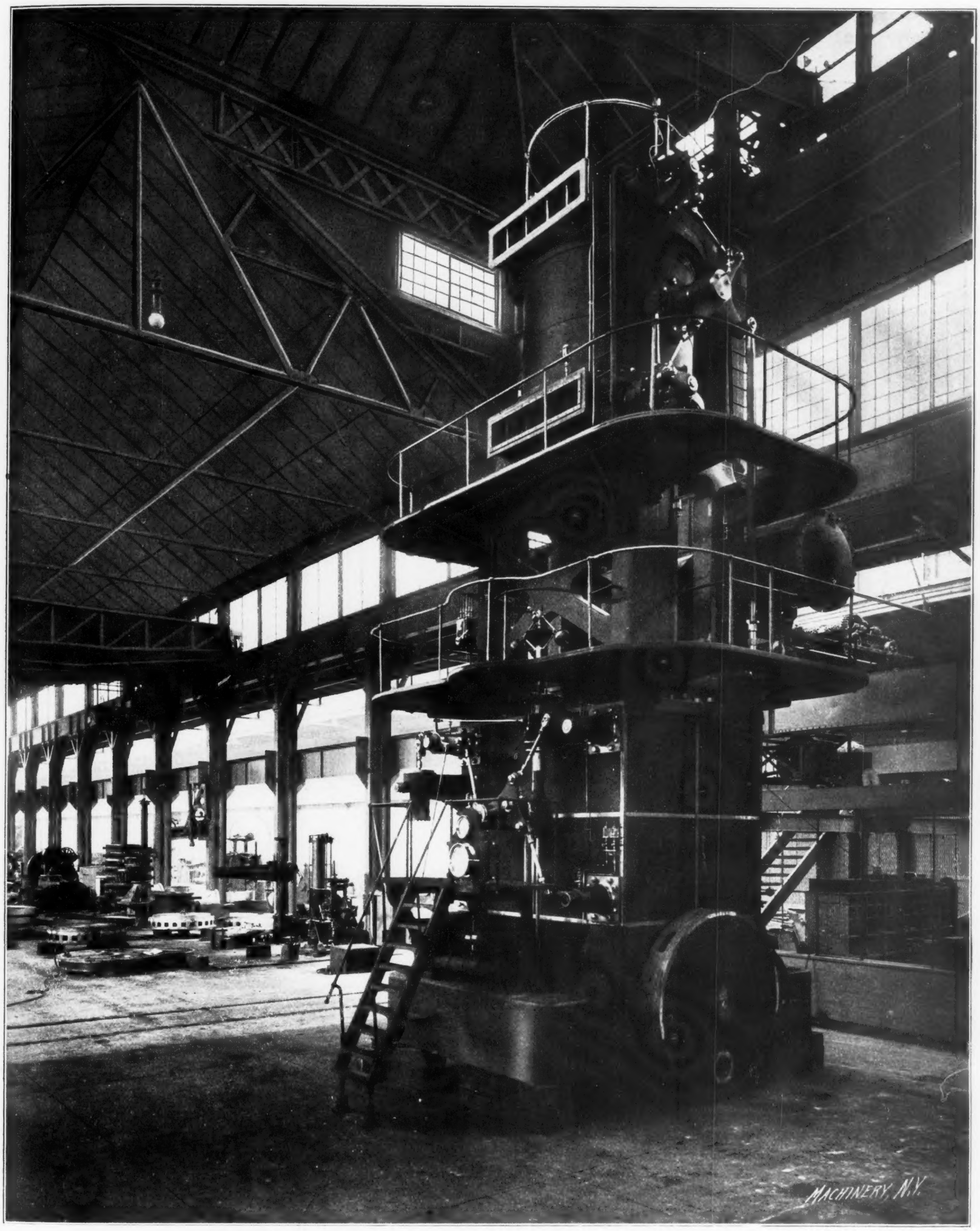


Fig. 2. Long Cross-head Type Vertical Blowing Engine built by the Mesta Machine Co.

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GOLD, AND ITS EFFECT ON PRICES

Bankers, financiers, business men, manufacturers, mechanics and, in short, everyone is vitally interested in the production of gold and the effect of the enormous increase in its production of late years on the finances of the world. Two very interesting books have been published lately on the subject, entitled "Story of Gold" and "The World's Gold," which are worthy of the consideration of every man sufficiently interested in monetary conditions to have some appreciation of the subject. The gold question has assumed an entirely different aspect since the demonetization of silver. Improved methods of mining and reduction have made it possible to work gold-bearing quartz rock with profit that only a few years ago would have been unprofitable. For example, the Treadwell Works of Alaska handle half a million tons of rock each year and find it profitable with a total production of gold of only about $2.50 per ton.

The increase of gold production has had a very appreciable effect on prices. Everyone suffers under the high prices of food, clothing and general living, and the majority cannot understand why costs have so greatly increased. Those who have made a study of this question say that it is due to the great production of gold, which in effect has cheapened it and made its purchasing power considerably less than when it was less abundant. To illustrate how greatly gold production has increased, a few statistics are in order: In 1883, 145 tons of gold were produced; in 1890, 200 tons; and in 1906, 608 tons. In other words, the production of gold had more than quadrupled in twenty years. The increased production of gold is even more strikingly apparent if we look at the production during a long period of years. In the time that elapsed since the discovery of America to the discovery of gold in California in 1849, the world's total production of gold was 4,621 tons, and in the forty years following the discovery in California the production was 7,160 tons. The production of forty years was fifty per cent more than in the three hundred fifty odd years preceding! If the production of gold is plotted, the curve will show a strikingly upward tendency during the last twenty years. The prospects are that the production of gold will increase even more during the next twenty years, which means according to monetary experts that prices will keep in step. Investments in stocks, bonds, mortgages and collateral security will depreciate, while investments in land, buildings, factories and other concrete examples of wealth will materially increase in apparent value. The man who buys a house will have good prospects of seeing its value, expressed in dollars and cents, increase greatly during the next few years, if the gold prophets are not at fault.

* * *

LABOR AND THE TARIFF

At the Tariff Commission convention held in Indianapolis, February 16 to 18, one of the best addresses made was that by Mr. Henry R. Towne, president of the Merchants' Association of New York. Mr. Towne had well analyzed his subject, and his reference to the interest of labor in the tariff is of especial value. "A tariff," he says, "is an indirect tax; its primary purpose is revenue; it may include the secondary purpose of protection. A tariff rate intended to prevent importation ceases to become a tax and becomes a subsidy. In considering any proposed tax, these questions should be considered: 1. On whom will it fall? 2. What revenue will it yield? 3. Whom, if any, will it benefit? If reliable data are available and if the tax is for revenue only, these questions may perhaps be easily answered, but if it is wholly or partly for protection, to foster and benefit certain classes of citizens, at the possible or intended expense of other classes, the problems become vastly complex. * * * In all discussions of the tariff the plea is made that a chief purpose in view is protection to American labor. Are we not liable to be misled by this plea? Does labor actually share, and, if so, to what extent, in the proceeds of the tax resulting from a protective duty? Is it not a fact, known to all employers of labor, that, in fixing any individual rate of wages, no thought whatever is given to the tariff; that in every case the employer takes account solely of the value or efficiency of the workman, and of the current rate of wages in the trade to which he belongs; that the workman is guided solely by his knowledge as to the current rate, and by his needs; and that each makes the best bargain that he can? Is it not true, further, that the rate of wages, in every trade, depends in large part on the cost of living, and that a high tariff, by enhancing the prices of the products which it affects, tends to increase this cost? Finally, is it not true that the real measure of a wage is its purchasing power, and that needlessly high tariff rates tend to diminish the purchasing power of wages?"

Mr. Towne further called attention to the United States as a great example of free trade, and said that nowhere else, at any time in the world's history, have trade and commerce been so absolutely free and untrammeled as they are to-day among the 80,000,000 people of this country.

The following are the more important of the conclusions given by Mr. Towne in his paper: The tariff embodies the heaviest tax which the people of the United States impose on themselves; it yields one-half of the national revenue; the present method of fixing tariff rates through Congressional committees acting chiefly on prejudiced evidence produces inequalities which are unnecessary, harmful and unjust; it is crude, unscientific and outgrown. A tariff influences wages indirectly only; it chiefly influences the cost of living, which in turn, determines the rate of a living wage; the true measure of wages is purchasing power; hence, anything tending to increase the cost of living, lessens wages; therefore, the tariff should be adjusted with regard to all its effects on all the people, not with regard to protected interests only. Mr. Towne considers that the remedy for our difficulties with the tariff would be a permanent, technical bureau of tariff research, which would collect, analyze and report industrial and commercial data to Congress, and that tariff revision should be made continuous and not intermittent. This would make the tariff flexible, and eliminate the bad influence of intermittent revision on business.

THE WASTE OF HUMAN ENERGY

A European state railway system was recently in need of sixteen new passenger locomotives of identical type. In the particular country referred to there are four locomotive building companies, and in order to "provide work" for the hands idle during the present depression the state railway administration divided the order for the sixteen locomotives among the four companies, ordering four from each. Under present economic conditions, when men willing to work are not permitted to do so, this course was undoubtedly a wise one; but one cannot help being impressed by the waste of human energy involved in the construction of the sixteen locomotives in this manner. Four complete sets of designs had to be worked out and approved, four complete sets of patterns made, and special tools required for the manufacture of the engines duplicated in four different places; and, of course, the work could not possibly be carried out under this arrangement as economically as if the sixteen locomotives had been built by one firm.

In England a reduction in the naval program advocated by the government about a year ago, was vigorously opposed by a portion of the press, not on the ground of national defense, but because a reduction in the quota of battleships to be constructed yearly would throw a number of men out of work; so, in order to give those men an opportunity to earn a living, these papers advocated a continuance of the policy of building battleships whether or not they were necessary for the country's defense.

It is not necessarily lack of employment alone that causes poverty, but also such aimless waste of human energy, which could be employed for the production of useful material. It is not necessary to go to Europe for examples of a similar waste of energy. During every period of trade depression we see examples of it in every country, and in almost every community; and this waste is likely to continue until we apply the axiom that men do not actually want *work*, considered by itself; but they do want the *product* of their work; and that wages, or compensation for work, do not come out of a large, indefinite, inexhaustible fund, but from the products of labor. If labor is expended for useless and unproductive purposes, the fund out of which wages must eventually be paid will be that much smaller, and the total reward for all labor must be less, even if no part of the product were diverted into other channels. Wasteful production, whether on a small or large scale, whether caused by individual or national ignorance or by economic conditions, is the worst enemy to progress; and the mere fact that men are paid for useless work in no way justifies the doing of the work.

The main reason for the industrial progress in America has been that human energy was highly valued; and, with all the waste in our natural resources, the percentage of waste in human energy has been smaller than in the old world. At present, the difference between conditions in this respect in the old world and in the United States is not so marked as in the past, and there is now a greater tendency in this country to employ labor in wasteful ways. Of course, non-employment itself is wasteful, whether it be voluntary or enforced; and whatever is done to prevent the waste of human energy is therefore an important step forward. It is fully as important to the progress of industry and the increase of wealth, as is the designing of labor-saving machinery and the development of improved methods of manufacture.

* * *

It is proposed to include a "worked-to-an-adequate-extent" clause in the French patent law. According to the *Times* the new amendment to the law will provide that patent rights shall lapse in France if the holder of the patent does not exercise his rights in France or in French colonies for a period of three years after applying for the patent. It also appears that the patentee will be expected to "exercise his rights" to an adequate extent. Of course, the purpose of this bill is exactly the same as that of the new British Patents Act, and the "exercise of rights" evidently is intended to mean the manufacture of the patented article.

EXPERIMENTS ON TWIST DRILLS—1

At the March 18, 1909, meeting of the Institution of Mechanical Engineers of Great Britain, a paper was read entitled "Experiments Upon Forces Acting on Twist Drills when Operating on Cast Iron and Steel." The paper was prepared by Mr. Dempster Smith of the Municipal School of Technology, Manchester, England, and Mr. R. Poliakoff of the Imperial Technology Institute, Moscow, Russia. The experiments, which have covered a period of three years, have been made by the authors of the paper at the Manchester School of Technology under the direction of Dr. J. T. Nicolson. Owing to the thorough manner in which these experiments have been carried out, and the extensive records made of the results obtained, together with the valuable conclusions that can be drawn from these results regarding the design of twist drills, the paper is of considerable importance, and the following abstract has been prepared with a view of presenting the most essential points. The results obtained in the experiments are the outcome of over one thousand tests.

Previous Experiments

Before discussing the experiments, it may not be out of place to give a brief *résumé* of the most important work done in this field of research. Amongst the first experiments of any note with twist-drills are those recorded by Professor L. P. Breckenridge in the Journal of the Lehigh University Engineering Society for October, 1898. According to these experiments the pressure on the drill when starting to cut is greater than the pressure on the drill when drilling with the full diameter. It was found that a one-inch drill required 1,450 pounds pressure when starting to cut, and 1,000 to 1,150 pounds pressure when drilling with the full diameter. The material cut, however, was not specified. It would appear from the results obtained that the material drilled was cast iron on which the skin or scale had not been removed, so that on this account a greater pressure was required to start the cut than to drill with the full diameter of the drill.

In 1902, Mr. Norris of the Bickford Drill & Tool Co. made several experiments with carbon steel twist drills in order to determine the most economical feed and speed, and also to get an idea of the power required when drilling cast iron. Mr. Norris found that a ⅜-inch drill would withstand a feed of 1/16 of an inch per revolution when drilling ordinary cast iron at a speed of 267 revolutions per minute, this being the coarsest feed provided on the machine. It was also found impossible to break drills larger than the above when operating at the same feed and on the same material. These experiments resulted in the adoption of feeds in the Bickford shops, which were about four times greater than those recommended by the Morse Twist Drill Company, at speeds not less than that given by that company. The conclusions from these trials were: The net horse-power per cubic inch of metal removed slightly decreases with the increase of feed for a given diameter of drill and speed. The net horse-power per cubic inch of metal removed also decreases with the increase in diameter of drill. The cutting speed for each drill varied, however, decreasing with the increase in diameter.

From a second set of power trials carried out on a specially rigid machine designed for testing the durability of the drills, Mr. Norris arrived at the following conclusions:

When the speed and feed are constant, the power required to drill tool steel is about 1.10 times, wrought iron about 1.65 times, and machinery steel about 1.90 times that required to drill cast iron. When the speeds and feeds remain constant, the power required is approximately proportional to the diameter of the drill. When the diameter of the drill and rate of feed are constant, the power required is approximately proportional to the speed. When the speed and diameter of drill are constant, the power required is approximately proportional to the feed.

A formula closely agreeing with these results, when operating on cast iron at a speed of 30 feet per minute, is:

$$\text{H.P} = \frac{63}{\sqrt{d}}\,(dt + 0.01)$$

where d is the diameter of the drill in inches and t the feed in inches per revolution of the drill.

Messrs. W. W. Bird and H. P. Fairfield, of the Worcester Polytechnic Institute, in a paper presented at the New York meeting of the American Society of Mechanical Engineers, December, 1904, gave the results of investigations on the torque and thrust exerted on a ⅝-inch "Novo" high-speed steel twist drill with varying rate of speed and feed on different metals.

The results of these experiments with a drill having an included point angle of 118 degrees was as follows: No material difference either in torque or end thrust was found by increasing the speed from 140 to 600 revolutions per minute when drilling soft gray iron. When operating on the same material at 420 revolutions per minute at varying rates of feed, it was observed that the torque did not increase as quickly as the feed, but the thrust increased very rapidly with coarse feeds. The torque required when operating on brass, tool steel, and machine steel was respectively 0.715, 1.67 and 2.44 times that required for cast iron. The corresponding thrusts were found to be 0.575, 1.7 and 2.6 times that required for cast iron. By varying the included point angle of the drill from 75 to 140 degrees, the end thrust increased rapidly with the angle, but no practical difference was observed in the torque.

A similar set of experiments were made later at the Worcester Polytechnic Institute by C. S. Frary and E. A. Adams. The results of these experiments showed that with a constant surface speed the thrust was nearly proportional to the diameter of the drill and also to the rate of feed. With different included point angles, the thrust decreased for angles from 150 to 90 degrees, and then increased for any further decrease in the angles. The moment could not be said to be proportional to the angle of the point, but almost proportional to the feed. The drill giving the minimum torque had a point angle of 130 degrees and the torque increased with drills having angles greater or less than this.

The twisting moment for ordinary twist drills is, according to these experiments, approximately expressed by:

$T = 13.5\ d\ (1{,}000\ t + 2.5)$

where

T = torque in inch-pounds,

d = diameter of the drill in inches,

t = feed in inches per revolution of the drill.

The Manchester Experiments

In the experiments made at the Manchester School of Technology, the results of which are reported in the paper referred to above, two forms of apparatus were used. The first apparatus was of comparatively simple character, suitable for use in the ordinary lathe. The experiments with this apparatus had for their object:

(*a*) To determine the twisting moment required for drilling with different diameters of twist drills at various speeds and feeds in cast iron and steel.

(*b*) The feeding force required for the various conditions mentioned in (*a*).

(*c*) To ascertain the twisting force required to enlarge a hole (which had previously been opened with a drill of smaller diameter) at different rates of feed on cast iron and steel.

(*d*) The corresponding feeding force required under the circumstances instanced in (*c*).

Ordinary commercial A. W. high-speed steel twist drills of ¾, 1, and 1½ inch diameter were used throughout these trials. The drills were ground on a twist drill grinding machine and the point thinned to about half the thickness of the web. The cast iron operated upon was of medium hardness and had the skin removed. The steel was Whitworth's (fluid-pressed), of medium hardness, having 0.29 per cent carbon and 0.625 per cent manganese.

Description of Apparatus

The arrangement of the lathe used for the first set of experiments is shown in Fig. 1. The lathe was driven by a 120 H. P. direct-current shunt-wound motor. A large air-cooled rheostat connected to the main circuit between the line and brushes allowed of the speed being varied from 100 to 300 revolutions per minute. The motor drove on to a countershaft whereon was mounted a three-step cone pulley similar to that on the lathe spindle. A further reduction of speed could be obtained through the double and triple back-gears in the machine, the ratio of which was 14.9 and 42.5 to 1, respectively, the combined arrangement permitted of the speed being varied from 1.5 to 450 revolutions per minute. A counter fixed to the end of the spindle indicated the revolutions made by the work.

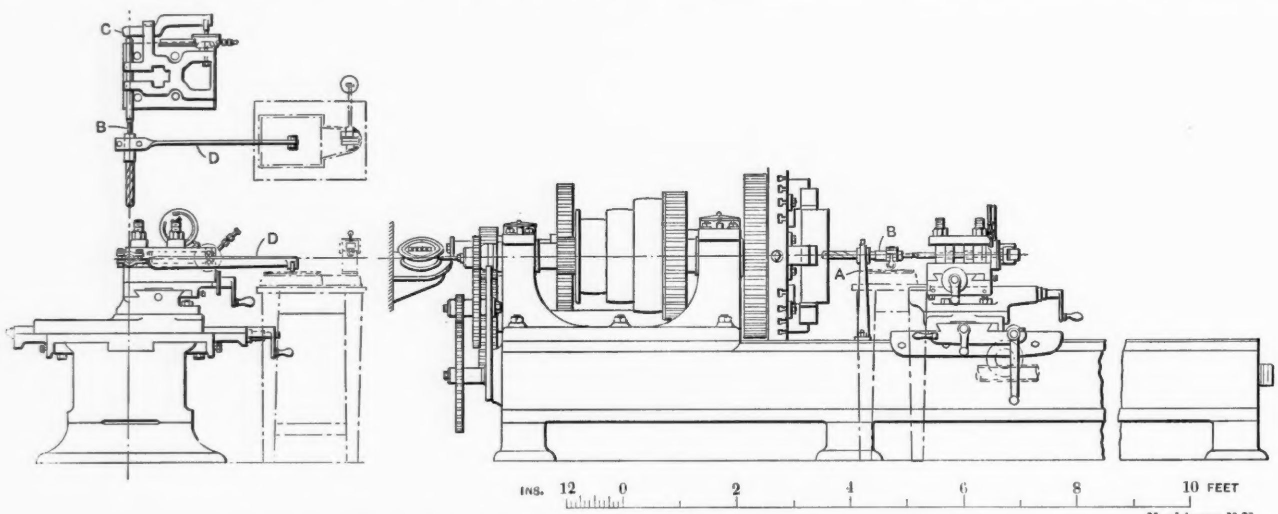

Fig. 1. Apparatus used for the First Set of Experiments to obtain Power required for Drilling

The stand *A*, bolted to the bed of the lathe, supported the drill close to the work. The drill was quite free to slide in the bearing provided in the stand. Suitable hardened steel bushings were used for the various sizes of drills. A small spindle or socket *B* received the tang end of the drill, and the thrust was taken by the knife-edged lever *C* and a diaphragm dynamometer fitted to a cast iron block which was bolted to the top slide rest.

The arm *D* was attached at one end to *B*, while the other end rested on a scale pan, and thus prevented the drill from rotating. As the arm advanced with the drill, the scale pan remaining stationary, the former was fitted with a knife-edged roller to reduce side twist on the drill, due to friction. The force exerted on the pan when multiplied by the length of the arm gives the twisting moment on the drill. By the engagement of the screw-cutting feed mechanism a definite advance was given to the drill per revolution of the work. The diaphragm dynamometer is similar to that shown in section in Fig. 2 and described in connection with the second apparatus. The speed in the ordinary force trials was kept constant at 10 revolutions per minute for each diameter of drills. The revolutions were observed on the counter at the end of the lathe spindle and a tachometer on the motor.

No perceptible difference was observed in the twisting moment and end-pressure with the variation of speed; that is, the cutting horse-power for a given diameter of drill and feed was directly proportional to the speed. The results of the experiments have been reduced to formulas, and are mainly so expressed in the following.

In the formulas given in the following, the notation below has been adhered to throughout:

T = torque in foot-pounds,
d = diameter of drill in inches,
t = feed in inches per revolution of drill,
P = end thrust in pounds,
f = cutting pressure in tons per square inch,
N = revolutions per minute,
V = metal removed per minute in cubic inches.

Results of Experiments with First Apparatus

The results obtained in the first set of experiments are expressed by the following formulas:

Trials (a) on medium cast iron:

$T = 1{,}220\,t + 2.5$ for ¾-inch drill, (1)
$T = 1{,}840\,t + 7.5$ for 1- inch drill, (2)
$T = 3{,}640\,t + 22.5$ for 1½-inch drill, (3)

An equation embracing the whole can be written:

$T = 12\,(d^2 - 0.35) + (500 + 1{,}350d^2)\,t$, (4)

A more approximate but much more simple expression for formula (4) would be

$T = (1{,}800\,t + 9)\,d^2$, (4$a$)

For the opening out trials (c) on cast iron, the twisting moment is given by the formula

$T = 2{,}812\,t + 17.5$ for opening ¾-inch hole to 1½-inch diameter, (5)

The twisting moment in trials (a) on steel follow a similar law to the cast iron. An expression for each size of drill is given below:

$T = 1{,}530\,t + 15$ for ¾-inch drill, (6)
$T = 3{,}850\,t + 18$ for 1- inch drill, (7)
$T = 7{,}800\,t + 48$ for 1½-inch drill, (8)

An approximate expression for the above which is near enough for all practical purposes is

$T = (3{,}200\,t + 20)\,d^2$, (9)

For the opening out trials (c) on steel:

$T = 1{,}500\,t + 6$ for opening ¾-inch to 1-inch, (10)
$T = 3{,}325\,t + 29$ for opening 1-inch to 1½-inch, (11)
$T = 5{,}025\,t + 31$ for opening ¾-inch to 1½-inch, (12)

The end thrust P is given by the following formulas:

For medium cast iron

$P = 95{,}600\,t - 250$ for ¾-inch-drill, (13)
$P = 93{,}400\,t + 180$ for 1- inch drill, (14)
$P = 154{,}000\,t - 600$ for 1½-inch drill, (15)

and

$P = 115{,}000\,t - 200$ for all diameters, (16)

In the opening out trials (d) in cast iron

$P = 11{,}330\,t + 160$ opening out ¾-inch hole to 1½-inch diameter, (17)

In the medium steel experiments for trials (b):

$P = 26{,}500\,t + 1{,}040$ for ¾-inch drill, (18a)
$P = 90{,}000\,t + 800$ for 1- inch drill, (18b)
$P = 155{,}000\,t + 1{,}300$ for 1½-inch drill, (18c)

and

$P = 160{,}000\,(d - 0.5)\,t + 1{,}000$ for all drills, (18)

For the opening out trials in medium steel:

$P = 15{,}200\,t - 60$ opening ¾-inch hole to 1-inch diameter, (19a)
$P = 25{,}500\,t + 60$ opening 1-inch hole to 1½-inch diameter, (19b)
$P = 30{,}000\,t + 200$ opening ¾-inch hole to 1½-inch diameter, (19c)

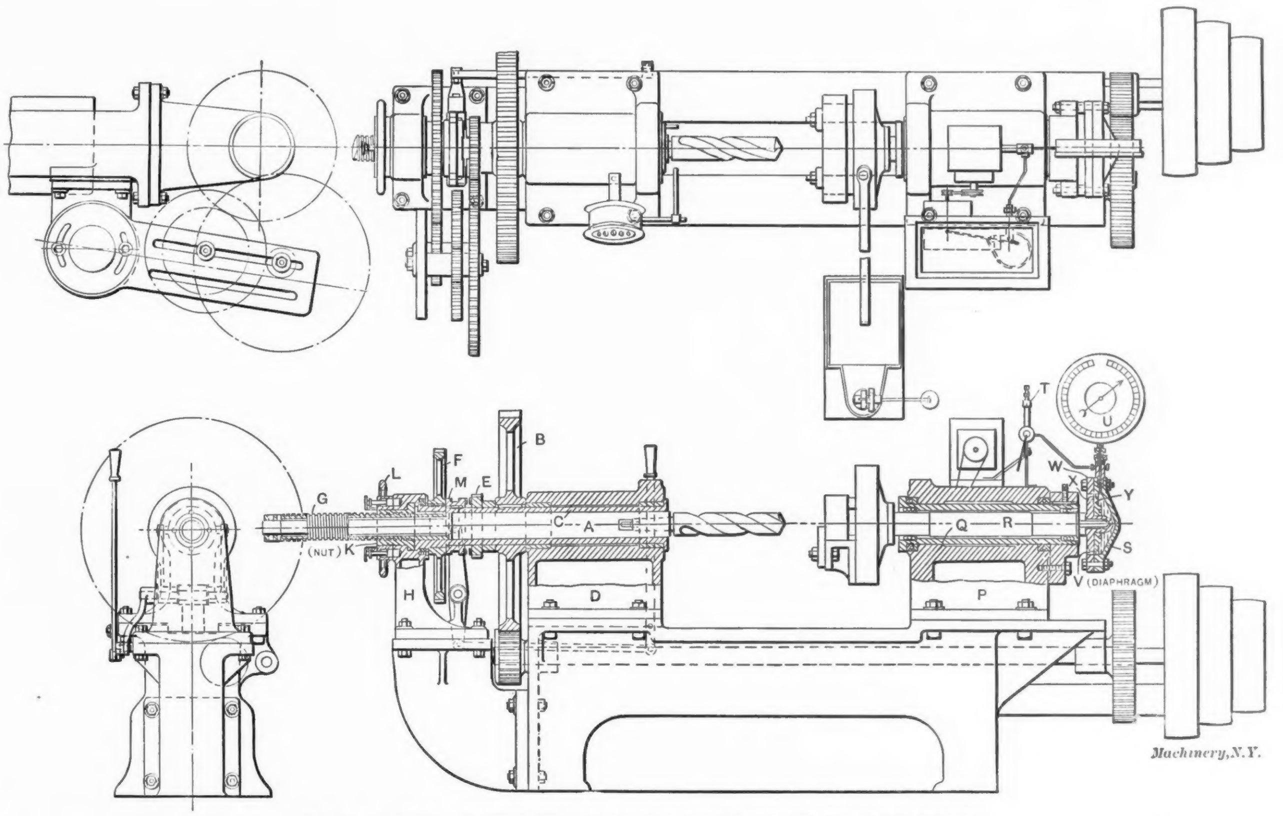

Fig. 2. Section and Elevation of Apparatus used in Second Set of Experiments

In no case did the end force P reach a maximum and then diminish when the drill was fully entered as observed by Professor Breckenridge, and it can only be concluded that he was operating on cast iron having a very hard skin or that the drill had a smaller pitch than those now in common use, *i. e.*, a keener angle. The opening out experiments show the fallacy of a common notion that but for the chisel point the drill would run into the work and break.

The apparatus employed and the results obtained in these first experiments were not entirely satisfactory for the larger drills and heavy feeds. This led to the construction of a second apparatus, and the making of a second set of tests, which will be described in the June issue.

* * *

It is stated in the *Marine Journal* that Sir Oliver Lodge recently succeeded in completely clearing away for a radius of sixty feet, a thick fog, by means of electrical discharges. The method employed consists in discharging electricity into the fog-laden atmosphere at a very high voltage, from a series of disks at the top of poles.

SOME NOTES ON BALL BEARINGS*

ASHER GOLDEN †

Mechanical friction is always a resisting force, whether utilized to effect the stability of structures, or to transmit motion from one part of a machine to another, or even to enable us to walk. In producing these effects, friction is essential and desirable, and means are often taken to increase it; such, for example, as the covering of leather transmission belts with adhesive substances and the covering of icy pavements to prevent slipping. On the other hand, friction is injurious in preventing relative motion of different parts of a machine and producing waste of energy. Under these conditions, friction is a serious disadvantage and its elimination a problem of grave importance. Any discussion relating to ball bearings, therefore, bears directly on the question of eliminating friction, and indirectly on the question of saving fuel and oil, and preventing the wear and tear of machinery.

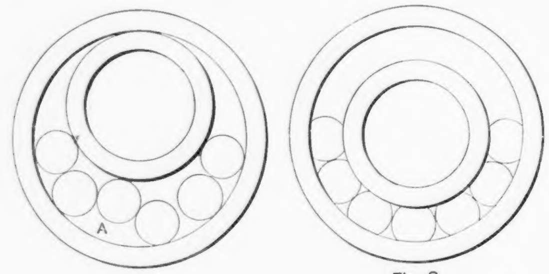

Fig. 1 Fig. 2 *Machinery, N.Y.*

Figs. 1 and 2. Method of Assembling a Ball Bearing

One way of minimizing the effects of friction suggested itself to the man who first applied wheels to a road vehicle. It must have been apparent to him that a vehicle would wear better and require less effort to move it if some means were provided to roll it along instead of having to drag it over the ground. This condition of affairs may be exaggerated by assuming that in one case we have two toothed racks in mesh and we try to move one relatively to the other; in the second case, that we replace one of the racks by a gear wheel and move it over the rack by means of a trunnion. The limit of the load required to effect motion in the first case, is that which will break the teeth, and in the second case, the effort required to overcome the comparatively small weight of the wheel and the friction between the meshing teeth. A comparative idea of the advantage gained by substituting rolling for sliding friction may be obtained approximately by taking two smooth blocks of steel, lubricating the surfaces in contact, and then tilting them; one block will begin to slide over the other when the angle through which they are tilted is between 8 and 9 degrees. If now, we replace the oil between the two blocks by a number of steel balls, we find on tilting the blocks, that they will begin to slide over each other when the angle is about 0.08 degree. Again, if we take two smooth horizontal blocks of steel, weighing, say 1 pound, it will require a force of approximately 2.7 ounces to move one over the other if the surfaces in contact are lubricated. If, instead of oil, we use steel balls between the blocks, only 0.027 ounce will be required to effect the motion. The only question raised against the use of the concentric ball bearing for stationary machinery and the cheaper grades of automobiles, is in regard to first cost. Aside from this, no one questions the relative advantage of the two-point ball bearing over the plain bearing, or even the roller bearing or cup and cone. In regard to ultimate cost, it may be safely said that the two-point bearing is the most efficient and cheapest. It only remains, regarding the ball bearing as a friction eliminator, to consider some of the inherent mechanical defects found in ball bearings at present on the market. These defects may be put under the following heads: Side slots in the rings for assembling the balls; small number of balls in races owing to absence of side filling slots; separators or spacers made of several disconnected pieces.

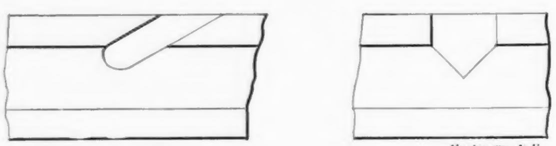

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Fig. 3. Two Forms of Filling Slots

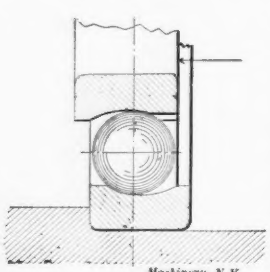

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Fig. 4. Displacement of the Rings of a Radial Bearing when it is subjected to an End Thrust

There are employed at present but two general methods of assembling a full or partly full ball bearing. One of these is to arrange the balls and races as shown in Fig. 1, and after placing in the crescent-shaped space *A*, as many balls as can be freely dropped in, the inner ring is shifted, leaving an annular space with the races about half filled with balls, as shown in Fig. 2. The remaining balls are then sprung in through slots in the sides under comparatively high pressure. This process is used extensively by Fichtel & Sachs (F. & S.): Standard Roller Bearing Co. (S.R.B.); and every other manufacturer of ball bearings, with the exception of three or four. The master patents for this process are owned by Fichtel & Sachs. Two forms of these filling slots are shown in Fig. 3. It is claimed by all those who employ the filling slot, that after the balls are assembled, they have practically a continuous race and that the bearing is as perfect as if the slot never existed. It may be said, however, that the existence of a filling slot as a defect is indirectly recognized by every bearing manufacturer. If it were possible to use radial bearings to carry only a purely radial load, almost any ball bearing, no matter how assembled, would give satisfactory service, provided the materials were fairly good and the bearing not overloaded; but, in many instances, radial bearings are used to carry, simultaneously, ordinary radial loads and comparatively excessive thrust loads. This applies particularly to radial bearings used in automobile front wheels, and to some extent in the rear wheels as well. Under these conditions, the inner and outer rings are relatively displaced, as shown in Fig. 4, and it is evident that if a bearing having a side filling slot be subjected to excessive end thrust, the balls are forced into the slot, a treatment which is manifestly

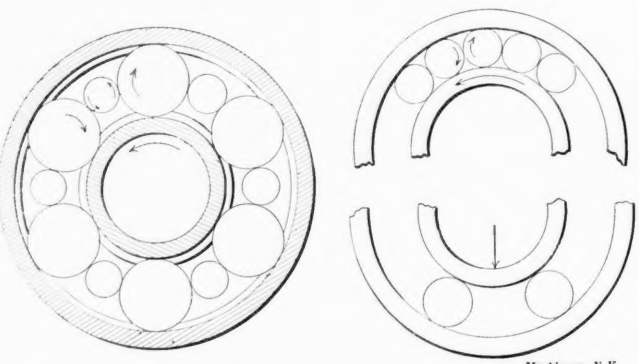

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Fig. 5. Bearing Designed to Eliminate Friction Figs. 6 and 7. Diagrams showing Action of Balls in a Full Bearing

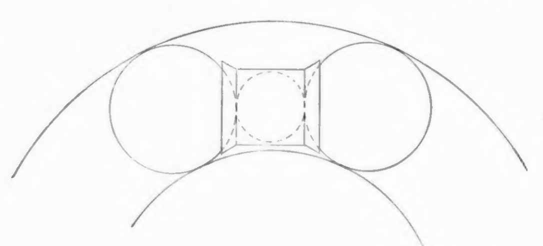

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Fig. 8. Type of Separator used in the Bearing shown in Fig. 5

* For additional information on this subject see the following articles previously published in MACHINERY: Ball Bearings, December, 1907, and January, 1908, engineering edition; The Discussion on Bearings Held at the December Meeting of the A. S. M. E., February, 1906; Designing Two-point Ball Bearings, April, 1906, engineering edition; Ball and Roller Bearings, December, 1906; Ball Bearings, February, 1905.

† Address: 1779 Broadway, New York City.

not very good for either balls or races. Of course, the extent to which this pinching of the ball in the slot will take place will depend on the depth of the filling slot. The Fichtel & Sachs Co. overcome this difficulty to some extent by employing a slot which is not quite as deep as the ball races. The balls are then forced through these slots under a pressure which is much higher than the thrust loads that can possibly be put on the bearings in practice. This is at least defensible practice, provided that the materials employed are of excellent quality. A bearing may be made without a filling slot, but in that case the limit to the number of balls which may be inserted is set by what will go into the crescent-shaped space A, Fig. 1. The balls are disposed around the circumference and some form of separator or spacer used to keep them apart. It has often been stated by those who employ this process, that there is no need of completely filling the races with balls; in other words, that a ball bearing which is only partly filled with balls, is equal to or better than one which is completely filled. One might almost reason instinctively that such statements are erroneous. That they are actually so will be shown.

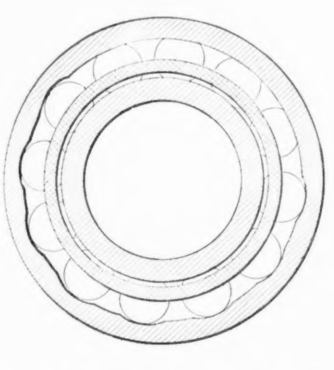


Fig. 9. Bearing with Outer Ring Grooved to permit the Use of a One-piece Separator

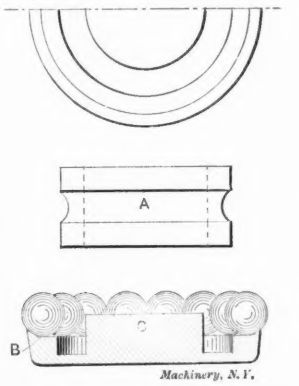


Fig. 10. Inner Race and Section through One-half the Cup used in Assembling the R. B. F. Radial Bearing

Fig. 11. View showing Method of Assembling the R. B. F. Bearing. After the Outer Race is heated with Oil, the Balls and the Inner Race are Forced into Place, after which the Assembling Cup is removed.

The permissible load in kilograms which a two-point ball bearing having one row of balls, will carry is given by the following relation due to Professor Stribeck:

$$P = \frac{K d^2 z}{5} \qquad (1)$$

where K is a constant depending on the properties of the material, the form of the ball race and the angular speed of the bearing; it may also be regarded as a factor of safety; z is the number of balls; the factor 5 takes account of the fact that only part of the balls carries the radial load; d is the diameter of the ball, taking 1/8 inch as the unit. For example:

If diameter of ball is 1/8 inch, $d = 1$
If diameter of ball is 1/4 inch, $d = 2$
If diameter of ball is 7/16 inch, $d = 3.5$
If diameter of ball is 5/8 inch, $d = 5$, etc.

From the above, it is seen that if we take two bearings having the same form of groove and the same dimensions for both of the balls and races, then if P_1 and P_2 are the carrying capacities of the two bearings, and z_1 and z_2 the corresponding number of balls, we have for the same angular speed

$$P_1 = \frac{K d^2 z_1}{5}$$

$$P_2 = \frac{K d^2 z_2}{5}$$

from which

$$\frac{P_1}{P_2} = \frac{z_1}{z_2};$$ or, in words, the carrying capacities of the two bearings are directly proportional to the number of balls. It is seen, therefore, that for a given bearing, other things being equal, the full type has a greater carrying capacity than that only partly filled with balls. While it is seldom stated that the carrying capacity of a radial bearing is some function of the angular speed, it will be seen that such is the case, since, if the speed is zero, the carrying capacity of the bearing is the rupture load of the balls; this load is far greater than the rated capacity of the bearing. For ball bearings made of high-grade material and accurately machined, K has the following approximate values for steady loads and uniform speeds.

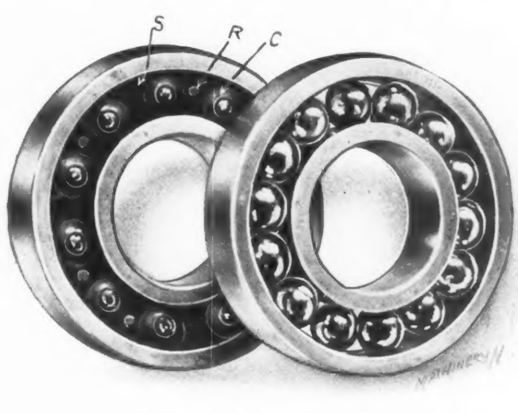


Fig. 12. Radial Bearings with and without Retainer

Revolutions per Minute.	Values of K.
10	20
150	18
300	15
500	10
1000	7.5
1500	5

From these figures, it will be seen that a given bearing will carry only one-fourth the load at 1500 R. P. M. that it will at 10 R. P. M. Since manufacturers employ the same material for all their bearings, and make the ball races of approximately the same form, it would be a simple matter to calculate the carrying capacities after adopting a value of K for a definite speed of rotation. There are some manufacturers, however, who assume high values of K in order to rate their carrying capacities high. There is no particular harm in this, provided the loads are not excessive. These

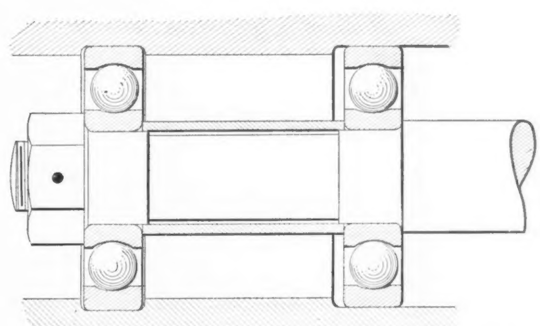


Fig. 13. Radial Bearings Arranged to take Axial Thrust

values of K even vary between the full and silent type of the same size bearings. It may be remarked, however, that the values of K may be the same for all the bearings, and that the capacities are calculated for different angular speeds, but no reason can be seen for such practice. For example, there is no reason why a manufacturer should rate the carrying capacity of his full type bearing, at say, 10 R. P. M., and the silent type of the same size at 300 R. P. M.

To determine the value of K used in rating the capacities, equation (1) is written in the form

$$K = \frac{P}{0.44\, d^2 z} \qquad (2)$$

where P is now given in pounds.

From equation (1), it is readily seen that the load per ball is lower in the full type than in the silent type. It may be argued from this that a full ball bearing will wear better that the other, but it is here necessary to remark that with the better grades of bearings, provided that the load is almost purely radial and within the limits set down in the catalogues, and the mountings made in accordance with the manufacturers' instructions, such a thing as wear is practically unknown, whether the bearing be of the full or silent type. But, as stated above, the load on the radial bearing is never free from end thrust; where this is excessive, the full bearing will give better service than the silent type, since end thrust is taken up by all the balls in the bearing, while a radial load is carried by between one and four balls, depending upon the type of bearing. Hence, everything else being equal, the full bearing is more satisfactory.

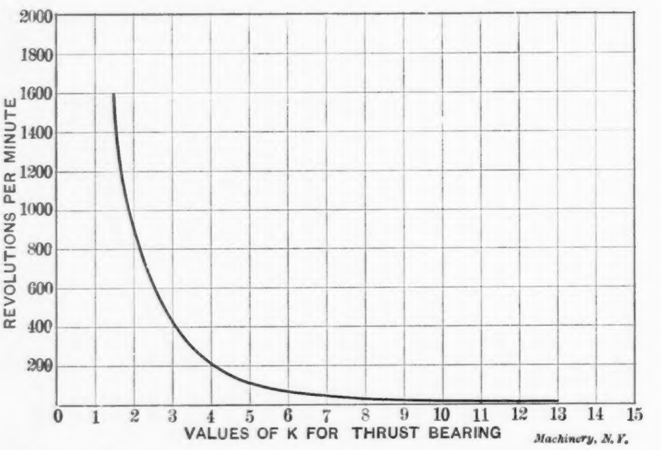


Fig. 14. Diagram showing how the Constant K, which is used in the Formula for Determining the Capacity of Thrust Bearings, varies with the Angular Speed

In regard to the third defect mentioned, it may be said that the employment of the discontinuous spacer, or one made up of several disconnected pieces, is very poor practice. Such a spacer has been used extensively by the D. W. F. Co., but is now being abandoned for a one-piece bronze separator. The discontinuous separator is also used by a well-known American manufacturer, but its use is incidental to the accomplishment of another end, which may be treated under the following head:

"Frictionless" Ball Bearings

Notwithstanding that the friction losses in a full ball bearing are very small, so small in fact as to be negligible, many attempts have been made to eliminate what little friction there is. One noteworthy example is that of the bearing just referred to. Here a series of alternately large and small balls is used, as shown in Fig. 5. This example is noteworthy only because it increases the friction which it is designed to eliminate, and introduces other serious disadvantages not found in the full bearing, or the silent type bearing, having a one-piece separator. Referring to Fig. 6, it will be seen that if the inner race rotates in the direction indicated, the balls will rotate as shown by the small arrows, and in the same relative direction as the outer race. There is in this case practically no sliding, except at the point of contact of every two adjacent balls where, it is seen, the ball surfaces are moving in opposite directions. At first glance, we may be led to infer that, since the balls are in contact and rubbing against each other, there must be an appreciable friction loss and consequent wear and tear. This inference is without foundation, since the balls do not contact under pressure, except in the case of those balls which are not carrying the load; then the pressure is the weight of the ball; this is negligible in comparison with the normal load on the bearing. Referring to Fig. 7, we see that if no load is placed on the inner ring, the balls will come together if the weight of the inner ring is less than that of the balls; but the moment we apply a load to the

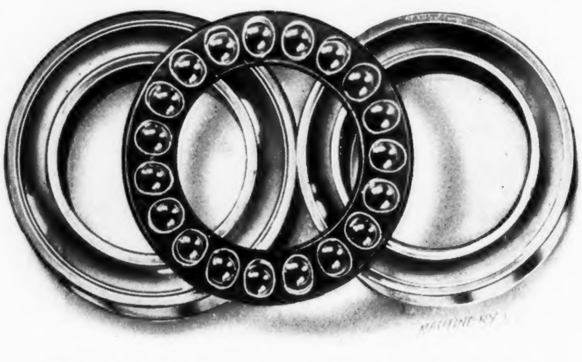


Fig. 15. Upper and Lower Races for Thrust Bearing, and Balls with Retainer having Elliptical Holes

inner ring, which is in excess of the weight of the balls, there is no pressure between the balls; if there were, they would be together. While it may seem to some that this matter is dilated on to an undue extent, the discussion is nevertheless warranted; this is done in order to correct an impression which seems to be general with those unfamiliar with ball bearing phenomena.

To overcome this imaginary ball friction, this bearing is provided alternately with large and small balls. Referring to Fig. 5, it will be seen that since the small balls are not in contact with the inner race, they are not constrained to rotate in the same direction as the large balls; the small balls, in fact, rotate in the opposite direction, and hence, between every two adjacent balls, there is practically pure rolling; that is, the negligible friction between the balls is eliminated—but at a serious sacrifice. First, since only the large balls are in contact with the inner and outer races, only these balls are useful in carrying the load. As stated in the foregoing, the carrying capacity (in pounds) of a radial bearing is $.44\ K\ d^2\ z$, so that a bearing of this type will carry a load of $.44\,K\,d^2 \times 6$, since 6 is the maximum number of balls that can be inserted in the bearing. A similar bearing when completely filled, will hold about 9 of the large balls; hence, we see that the bearing completely filled with large balls will carry three pounds to every two of the bearing having alternately large and small balls. Second, to sustain the small balls, it is essential that some form of sepa-

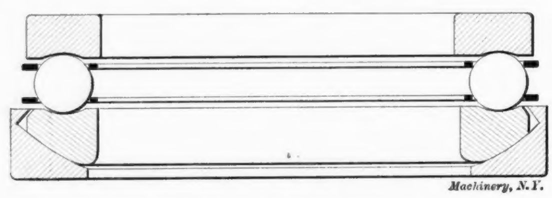


Fig. 16. Section through Thrust Bearing, the Lower Race of which is in Two Parts

rator be used. The separator used by the manufacturer of this bearing has the form shown in Fig. 8. It will be seen here that the ends of the separator contact with the balls, and that although the friction in this case is admittedly very small, it is considerably greater than in a similar full type ball bearing; the friction is further increased, owing to the fact that the makers of this bearing state that their bearings do not require oil. In addition, if one of the large balls should break, the bearing falls apart. This defect is a very serious one, and is common to all the bearings employing discontinuous separators.

As pointed out above, all other things being equal, the carrying capacities of two bearings are directly proportional to the number of balls; hence, it is evident that under all

conditions of service a bearing that is completely filled with balls is to be preferred to one that is only partly filled, provided that the side filling slot can be done away with. Owing to the apparent impossibility of introducing a sufficient number of balls to completely fill the race, most manufacturers have made use of the filling slot, while a few have taken the alternative step of avoiding the filling slot by employing fewer balls. The extent to which some manufacturers may go in order to gain the advantage of a large number of balls, as well as to avoid the discontinuous separator is shown in Fig. 9. This bearing, made by the Auto-Machinery Co. ("A. M.") of Coventry, England, has eight filling slots. The main object in doing this, however, will be best seen from the following abstract of an article in *The Automotor Journal*, January 25, 1908, describing this bearing.

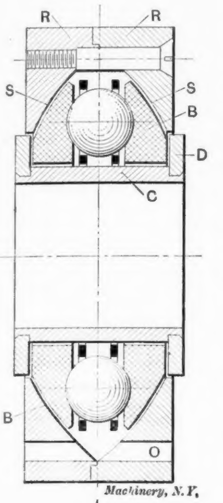


Fig. 17. Bearing Designed for Axial Thrust in Either Direction

"One of the principal difficulties in connection with the use of a cage, is its interference with the process of assembling the component parts. If the balls are inserted separately, they present no great difficulty, but when surrounded by a cage, special provisions are necessary. Some firms have for this reason divided the cages of their bearings, so that they can be fitted in place afterwards, but the Auto-Machinery Co. dislike the use of a divided cage, and have thus evolved a method of inserting the balls and their cage *en bloc*." After the outer ball race is circumferentially grooved, "it has a series of slots cut across its inner surface. These slots, however, are cut on one side only, and do not reach quite to the center of the groove; moreover, they are not provided round the entire circumference. This object is to facilitate the insertion of the balls *en bloc* with their cage * * *."

It is an unfortunate circumstance that the manufacturers of this bearing dislike the divided cage. It may be remarked that the advantage of inserting the balls and their one-piece separator as a complete unit, cannot be readily seen. If there is an advantage, it has been gained, in this case, by a great sacrifice.

We shall now describe the R. B. F. radial bearing made by the Société Française des Roulements à Billes. This bearing is unique in that it has none of the defects discussed above. There are no filling slots either in the full or silent type. The full type contains as many balls as it is possible to get into the races. The silent type has a continuous separator. In the assembling of the R. B. F. radial bearing, two similar steel cups are used of the form shown in Fig. 10. After placing the inner race *A* of the bearing over the central core *C* of one of the cups, the balls are laid around the groove *B*, and the inner race and balls are then covered by the second cup. The outer ring is now heated in a bath of oil, and placed over the assembled ball and cup unit as shown in Fig. 11. This complete unit is now placed in a press and the balls forced into position. After the outer ring has cooled down to normal temperature, it is impossible to detect the slightest axial play. This method of assembling a full ball bearing is an excellent check on the quality of the bearing, since, if the balls are improperly heat treated, they are either deformed or broken, as the case may be, when pressure is applied to force them into the outer race, and are, therefore, rejected. The spacer or separator used by the R. B. F. Co. consists, as will be seen from Fig. 12, of two steel stampings *S*, each having a number of saucer-shaped cavities *C* which serve to engage the balls and keep them apart. The two halves of the spacer are kept apart by a number of distance pieces, and are fastened together by means of rivets *R*. Sufficient room is allowed between the cavities and the balls to provide for a liberal film of grease or oil, so that there is never metal to metal contact under normal running conditions.

Radial Bearings as Thrust Carriers

While ball bearing manufacturers, as a rule, are desirous of limiting the use of radial bearings to their normal function, it has nevertheless become the practice among bearing users to employ the radial bearing to take axial thrust in addition to the normal radial load. To meet this demand, the bearing manufacturer has been obliged to stretch a point and suggest means whereby the radial bearing can also be used as a thrust bearing. To this end, it is considered good practice where two bearings are mounted on the same shaft, to make the inner ring of both bearings a light driving fit on the shaft. The outer ring of one bearing is then made a sliding fit in its seat and clamped up far enough to allow it from 0.5 millimeter (0.0196 inch) to 1 millimeter (0.0393 inch) axial play; the outer ring of the other bearing is also made a sliding fit, but is allowed considerable axial play. The first bearing takes the radial load, and end thrust, and the second bearing, a purely radial load only. This arrangement, shown diagrammatically in Fig. 13, is a preventive against wedging of the bearings, and is an assurance of long life. It is not uncommon, however, to find ball bearing users who are bent on carrying out their own ideas in regard to mountings. It is from these that most complaints come.

It may be said here that although the arrangement just described is considered good practice, it is decidedly poor practice to use a radial bearing to take the end thrust of a

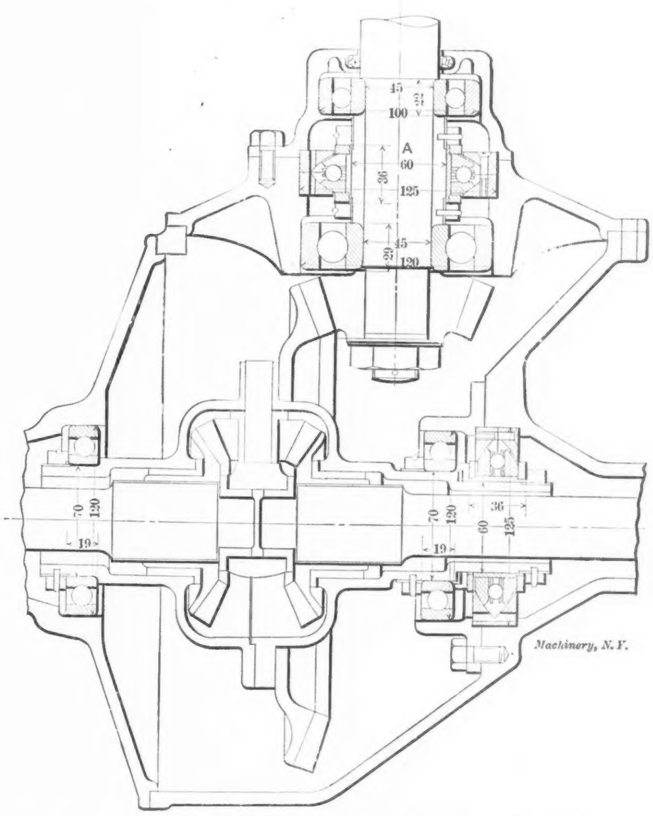


Fig. 18. Automobile Rear Axle and Differential Gearing equipped with the Double Thrust Bearing

shaft having a low speed of rotation. This applies, particularly, where the end thrusts are excessive, as in automobile front wheels. This is the real cause of the complaints heard on every hand as to the unsuitability of two-point bearings in automobile front wheels, and has led many to adopt some form of inclined roller or cup-and-cone bearing, both of which are far inferior to the two-point bearing. The remedy in these cases is very simple. The trouble can be effectively eliminated by making the outer rings of the two bearings a sliding fit and allowing them considerable axial play, so that they cannot possibly take end thrust. This thrust is then taken on a thrust bearing or collar placed somewhere on the shaft, usually between the other two. If the speeds of rotation are very high, say above 1,000, there is no particular harm in taking thrust on a radial bearing, since at high speeds, radial bearings are better thrust carriers than thrust bearings.

Thrust Bearings

For the determination of the permissible load of a thrust bearing, a relation analogous to equation (1) is used. The load P in kilograms is

$$P = K\, d^2 z \qquad (3)$$

This is for steady loads and uniform speeds. This equation is the same as (1), except that the factor 5 drops out, since it is here assumed that all the balls are effective in carrying the load. The curve Fig. 14 shows how K varies with the angular speed. The values of K for speeds usually given in catalogues are shown in the following table:

Revolutions per Minute.	Values of K.
10	12.5
150	4.5
300	3.5
500	3
1000	2
1500	1.5

For parts that execute very little motion, such as crane hooks, K may be taken as high as 18 to 20. For very high speeds above 1500, the ordinary thrust bearing is practically useless for taking end thrusts. Centrifugal force, at these speeds, plays a very important part. The balls are driven toward the outer edge of the race, and against the walls of the ball retainer. To avoid this condition, use is made of a retainer with elliptical holes as shown in Fig. 15. This retainer also permits the shaft to deflect without pinching. It is used in America by the Société Française des Roulements à Billes, and the Hess-Bright Manufacturing Co., who are the only American licensees under the patent. The manner in which the permissible load varies with the speed is seen from the following table constructed for a particular bearing.

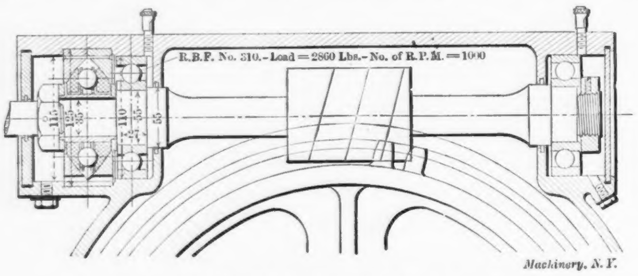


Fig. 19. Double Thrust Bearing applied to a Worm Shaft

Revolutions per Minute.	Load in Pounds.
10	11,000
150	3,740
300	2,640
500	2,420
1000	1,760
1500	1,540

Every shaft, no matter how short, is deflected under load; this deflection, although too small to be seen in many cases, can at least be calculated. In order to take the end thrust of such a shaft, it is customary to provide a thrust bearing having the lower surface of the bottom race of spherical form. The seat for this bearing is machined to the same form. This permits the shaft to deflect and the bearing to move as a complete unit with the shaft. It assures that the plane of the bearing will always be perpendicular to the axis of the shaft, and that the load will be uniformly distributed among all the balls. The use of such a bearing has two disadvantages: first, in the machining of the seat, a special fixture is required to allow the cutting tool to swing over the required radius of curvature of the seat; second, the material of which the races are made is hardened, while the seat for the bearing is machined out of ordinary unhardened material, so that appreciable wear will take place in a comparatively short time. There need be no objection to this bearing, however, if the speeds of rotation are very low, or the loads are very light. To overcome these disadvantages, the Société Française des Roulements à Billes, supplies a thrust bearing having the lower race made of two parts, one floating within the other as shown in Fig. 16. These two parts are made of the same material and heat treated in the same way, so that there is practically no wear even when the speeds of rotation are high and the loads great. All that is necessary to use the bearing, is to machine an ordinary flat seat; no special tools or fixtures are required.

In order to assemble the two parts of the lower race, the bottom portion is heated in oil, and the upper portion forced into position under pressure. The advantage of this arrangement is, that the lower race, although made up of two parts, can be handled as a complete unit. An exterior view of this race is shown in Fig. 15.

It is often desired to take end thrust on a shaft in both directions, as for example, where bevel or worm gearing is used, or on a marine propeller shaft. To do this, it is usual to employ two distinct thrust bearings. Such an arrangement has the disadvantages spoken of above in connection with the single thrust bearing. To permit of end thrust being taken in both directions, the Société Française des Roulements à Billes, manufactures the bearing of which a section is shown in Fig. 17. The bearing consists of two outer rings R, held together by screws, and provided with a number of oil holes O. The inner surfaces of these rings are machined to a spherical form to accommodate the outer surfaces S of the rings B. The rings D are forced on the collar C after expansion by heat in the manner described in connection with the other products of the R. B. F. Co. Every working part of the bearing is enclosed and it is entirely self-contained. One application of this bearing is shown in Fig. 18 in connection with an automobile rear axle and differential, and Fig. 19 shows an application to a worm and wheel.

* * *

THE MACHINING OF MANGANESE STEEL

In an article in the *Railway and Engineering Review*, Mr. James B. Strong refers to some interesting particulars regarding the machining of manganese steel. This steel, whether cast or rolled, is not an extremely hard metal, as most people suppose. It is not as hard as chilled cast iron, and only about 20 per cent harder than high-carbon Bessemer steel; but manganese steel, properly treated, is extremely tough. The particles hang together most tenaciously, and when subjected to severe strains, the metal flows and can endure repeated distortions without surface fractures or cracks. There is practically no loss from the surface of manganese steel in small pieces when subjected to abrasive wear of any nature, except where there is a constant renewal of sharp cutting edges, such as with emery and other grinding wheels. The idea that manganese steel will cut or grind chilled iron or steel-tired wheels is not correct, as a cutting edge of manganese steel will not stand up at all against harder metals.

It is interesting to observe the cutting action on manganese steel of drills or planer tools made of high-grade tool steel which is much harder than manganese steel. The tool takes hold on cast or rolled manganese steel, at first, and cuts, but the chips will not come off as with ordinary steel. They drag, and the tool soon slips, heats up and the cutting edge fuses or crumbles. Cast or rolled manganese steel can be cut slowly, however, by specially shaped and hardened tools in a powerful and heavy machine free from vibration; but even then the cutting edge is very short-lived and must be renewed constantly.

* * *

The strength and elasticity of copper depends to a large degree on its heat treatment. Some experiments to ascertain to what extent the heating and subsequent cooling of copper influences its strength were recently undertaken, the results of which are given in *Engineering*. Ordinary commercial copper wire would stand 44 bendings before breaking. The same wire when heated to bright red heat and suddenly cooled in water would stand 73 bendings, while if it was slowly cooled in the air, after the heating, it would break at 49 bendings. When heated to a dark red heat and cooled in the air it would break at 41 bendings, but, if cooled in water first, at 46 bendings. This seems to indicate that if copper is heated to a red heat it should be suddenly cooled in water rather than by permitting it to cool in the air, if the strength is not to be reduced.

DATA ON HIGH-SPEED DRILLING

GEO. E. HALLENBECK*

The accompanying diagrams show the results of some tests made with high-speed drills on the Baker Brothers high-speed drilling machine. They represent a part of the experiments which have been made at the works of the above company with a view of securing the most efficient design of machine for driving medium size drills, that is to say, drills from ¾ to 2 inches in diameter.

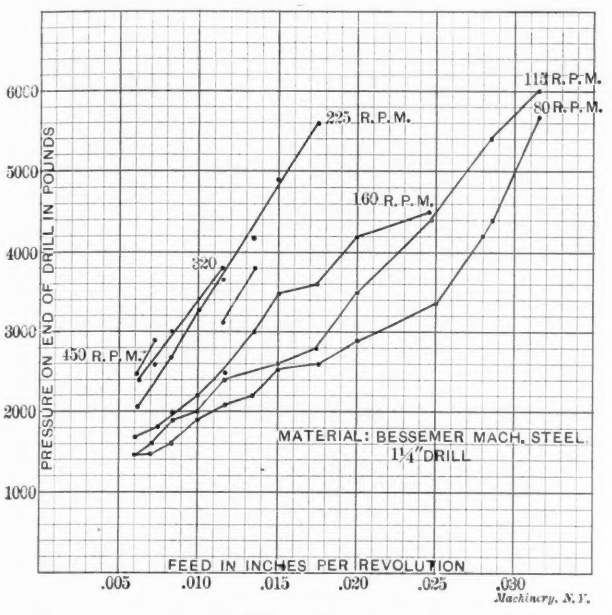


Fig. 1. Diagram showing Relation between End Pressure and Feed in High-speed Drilling

Some of the drilling which has been done on these machines is little short of marvelous. Thus 1⅛-inch holes have been drilled through 4¼-inch blocks of cast iron at the rate of 8 2/3 seconds per hole, or a vertical feed of 29 inches per minute. (See MACHINERY, June, 1908.) Several holes were drilled at this speed without necessitating the regrinding of the drill. Some 15/16-inch holes were drilled through a ¾-inch machine steel plate at the rate of 3½ seconds each; a great many similar tests have been made. When we stop

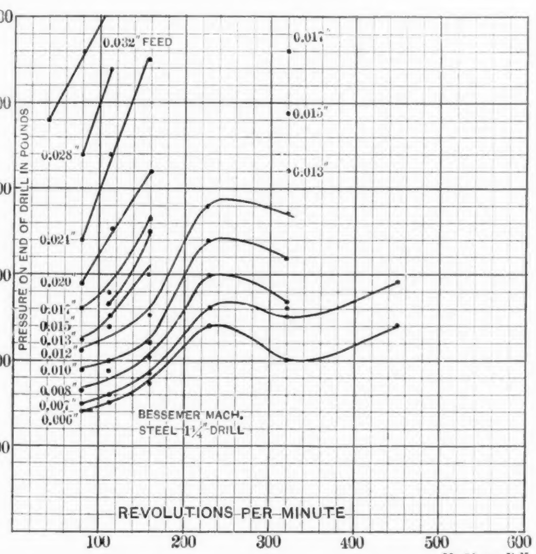


Fig. 2. Diagram showing Relation between End Pressure and Cutting Speeds

to consider that the average punch press when punching a 15/16-inch hole in ¾-inch material will make about 20 to 30 strokes a minute, or, in other words, it will take two or three seconds to punch the 15/16-inch hole which was drilled in 3½ seconds, the really remarkable performance stands out more clearly, especially so when it is understood that a number of holes were drilled at this rate without resharpening the drill. The holes were drilled without lubricant of any kind.

Among other things it was desirable to know just what the vertical thrust on the spindle was in order to properly design the thrust bearing and feeding mechanism, experience having demonstrated that the load on the feeding mechanism was far greater than it was ordinarily thought to be.

Fig. 1 shows very clearly the result of some of these tests made with a 1¼-inch drill. The variation of the pressure on the end of the drill is shown in relation to a gradually increasing rate of feed. Several tests are shown at speeds varying from 80 R. P. M. to 450 R. P. M. It will be appreciated that the conditions of these tests are such that nothing more than general conclusions can be drawn from the curves. In the curves shown in Fig. 1, it will be noted that, as a general proposition, the effect of increasing the feed is to increase the pressure of the drill point in a straight line ratio, although the tests made at 80 R. P. M. would indicate that there was a tendency toward an increasing pressure as the feed was increased. So far as it was possible to observe, there was no great variation in the vertical thrust with the increasing depth of hole after the first ¼ inch had been drilled.

Fig. 2 shows the same series of tests as shown in Fig. 1, but here the feed is held constant and the speed made a variable. These curves, together with those shown in Fig. 5, are perhaps the most interesting of the series from the fact that they show a peculiar decrease in pressure by increasing

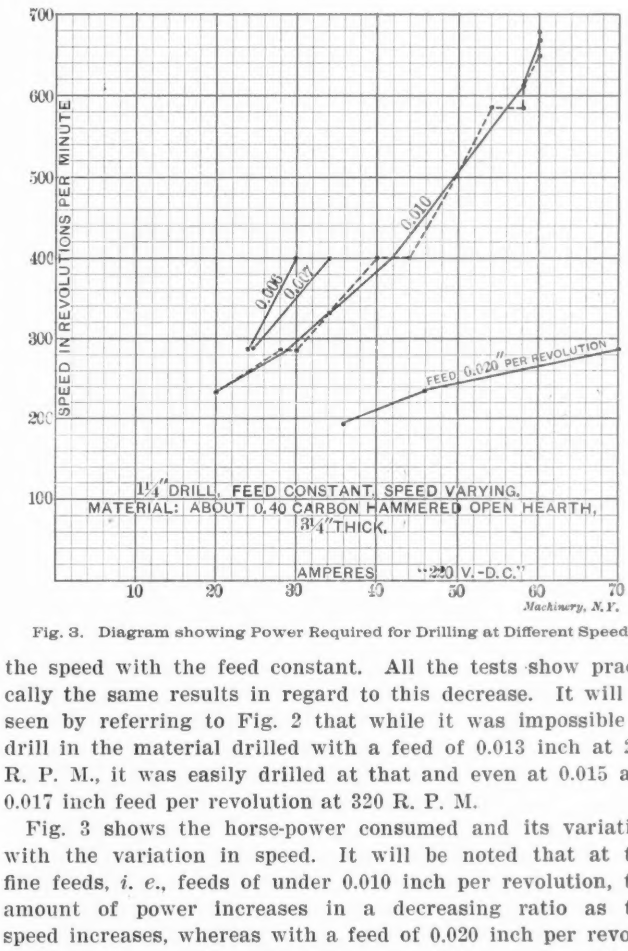


Fig. 3. Diagram showing Power Required for Drilling at Different Speeds

the speed with the feed constant. All the tests show practically the same results in regard to this decrease. It will be seen by referring to Fig. 2 that while it was impossible to drill in the material drilled with a feed of 0.013 inch at 225 R. P. M., it was easily drilled at that and even at 0.015 and 0.017 inch feed per revolution at 320 R. P. M.

Fig. 3 shows the horse-power consumed and its variation with the variation in speed. It will be noted that at the fine feeds, *i. e.*, feeds of under 0.010 inch per revolution, the amount of power increases in a decreasing ratio as the speed increases, whereas with a feed of 0.020 inch per revolution, just the opposite seems to be true. The ampere readings shown on the diagram represent the total electrical input into the motor, no deductions having been made for either the losses in the motor or in the machine itself, as the data desired is the amount of power which will have to be delivered to the machine.

Fig. 4 shows the variation in power required under a constant speed with varying feed, the increase in power consumption being apparently a constant ratio.

Fig. 5 shows the remarkable increase in production which can be secured by increasing the speed. The curves are plotted showing the maximum feed at which the stock was successfully drilled without destroying the drill. With the next higher feed the drill would be destroyed. In order to

* Superintendent, Baker Brothers, Toledo, Ohio.

secure as nearly uniform conditions as possible, all of one series of tests were run with the same drill, it being resharpened when necessary. The curve No. 2 shows quite conclusively that the drill would give a greater production without failing at 200 R. P. M. than it would at 250 R. P. M., and also that it would give a much greater production if the

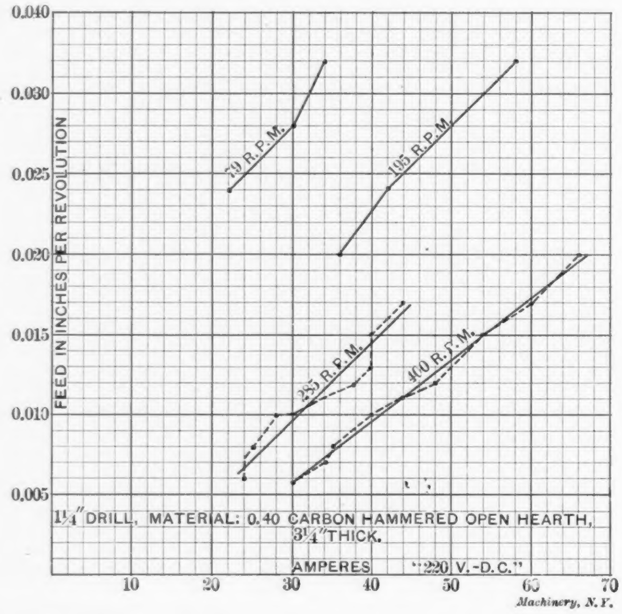


Fig. 4. Diagram showing Power Required for Drilling when Feed Varies

speed were still further increased to 440 R. P. M. This may be an index to the solution of the much mooted question of whether a slow speed and heavy feed or a high speed and fine feed is preferable. It would seem that the adherents of each of the above sides of the question would get into trouble as they began to gradually increase or decrease their speed

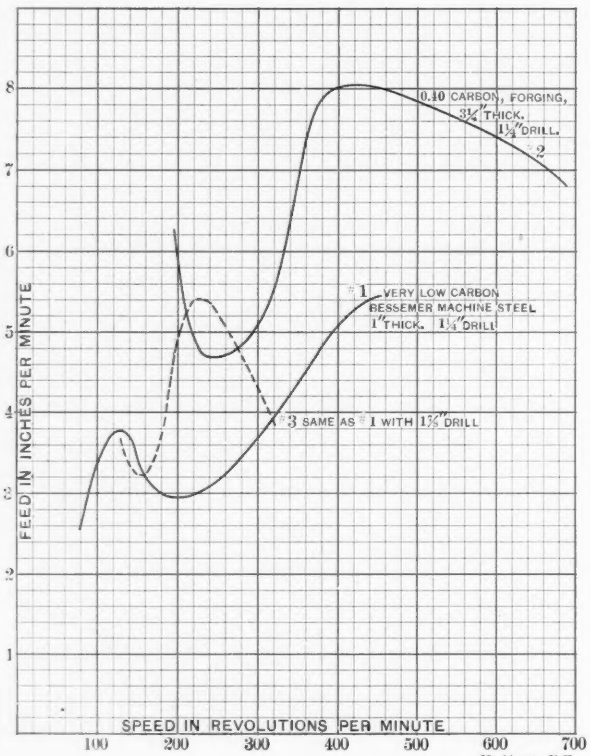


Fig. 5. Diagram indicating Productive Capacity of Drills at Various Speeds

and so would quickly come to the conclusion that they could gain nothing by going in that direction.

These tests on drilling, although representing many hundreds of drilled holes, are by no means given as conclusive, they having been altogether too few in number to establish permanently the conclusions to which a study of the diagrams would naturally lead; yet they seem to point quite strongly to the conclusion that the best results will be obtained at comparatively high speeds and moderate feeds, as it is possible to carry a heavier feed at a high speed than at the medium speed. It was this fact, often recurring in the writer's tests, that led to making the series of tests the results of which are shown in Fig. 5, for the purpose of demonstrating whether such was actually the case, or whether the apparent increase was due to other causes. In conclusion the writer would add that the majority of the drilling shown on the accompanying diagrams was done with a 1¼-inch drill, and the number of times required to sharpen it were very few.

The Baker Brothers' high-speed drilling machine on which these tests were made is shown in Fig. 6. It is driven by a 4 to 1 variable speed motor, and has a speed range from 70 to 700 R. P. M. By providing suitable gearing a wide range of feeds between 0.006 and 0.032 inch per revolution is secured on this machine. The machine on which these tests

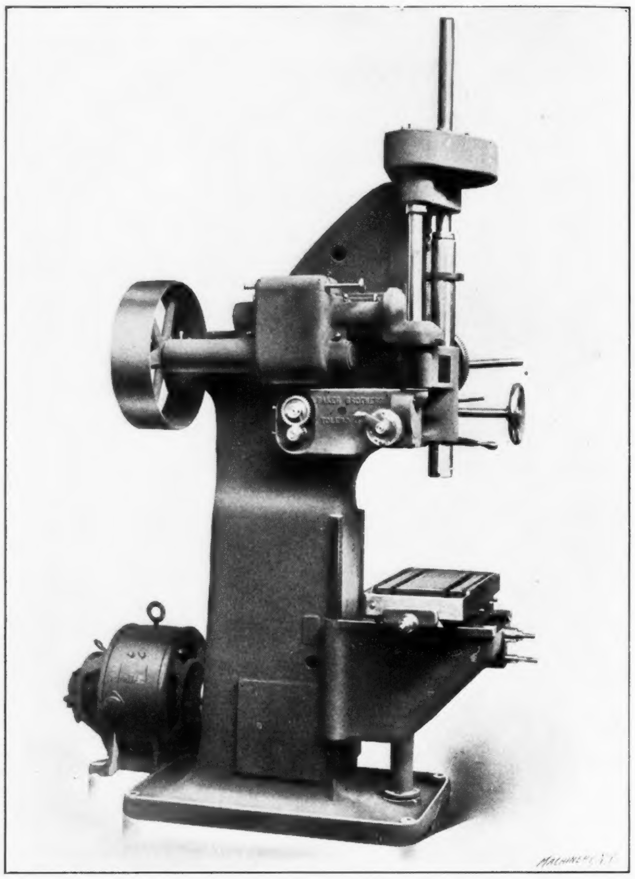


Fig. 6. Baker Brothers High-speed Drilling Machine on which Tests were made

were made was provided with roller bearings; outside of this feature it was the regular high-speed drill as now built by Baker Brothers.

* * *

The five- or ten-cent cotton mitts which are so largely bought by workingmen may be waterproofed by dipping them in melted paraffine; or if a thinner coat is preferred, and only on the palm of the mitts, melted paraffine may be brushed over their surface. For handling damp bricks, for working with plaster, or cement, paraffined mitts are far superior to the original. Leather gloves may be waterproofed in the same way. The coating of paraffine may be removed as often as the surface needs it.

* * *

It is stated by the London *Times* that the British Government has, under the new Patents Act, revoked a patent covering an American invention for the production of a lock-stitch sewing machine "capable of operating at a very high speed with smoothness, ease, and but little noise, upon either thick or thin work." The machines covered by the patent have been wholly manufactured in the United States, and since the new patents act came into force, no steps have been taken to work the patent in Great Britain, and it has therefore been revoked. The patentee must also pay the applicants for the revocation their expenses, amounting in this case to $200.

MACHINE SHOP PRACTICE*

CYLINDRICAL GRINDING—2

In the first installment of this article in the April issue, some information bearing on wheel selection and preparation of work was given; while these subjects are very important, they do not constitute all that is to be considered, if a grinder is to attain its maximum of efficiency. A wheel which is adapted perfectly to a certain grade of steel, for example, will not work satisfactorily if the relative surface speeds of the wheel and work are not approximately correct, as the work speed affects the wear of the wheel which, when excessive,

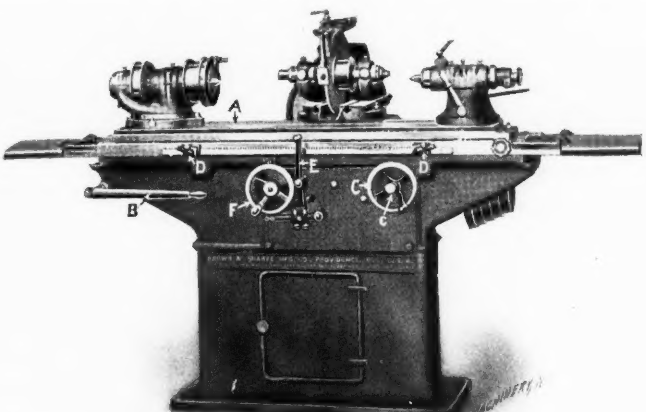


Fig. 1. A Universal Grinder built by the Brown & Sharpe Mfg. Co.

also affects the finish of the surface being ground. The amount of stock that the wheel removes for a given amount of wear, may be increased or diminished by varying the work speed, the wheel wear being excessive when the speed is too high. This close relation between the work speed and the wheel wear makes it possible to use a wheel which is somewhat harder than it should be for a given piece of work, with fairly good results, by increasing the work speed with the result that the grit is dislodged more easily, and consequently does not remain long enough to cause glazing, which would otherwise take place; this practice, however, is not to be recommended. As there are a number of factors, such as kind of material, finish desired, etc., which determine the proper work speed, it is impractical to say just what this should be. A speed of twenty-five feet per minute might be correct for grinding a certain piece of steel, and not correct for another steel piece having a different carbon content. The finish of a ground surface, as stated, is affected by the work speed, and it is possible to grind a very rough or smooth surface by simply varying the speed, depth of cut, and side feed of wheel, the surface becoming smoother as these are diminished. For this reason the speed and feeds (when within, say, 0.002 inch of the finish size) are often reduced before taking the finishing cuts. The best method of ascertaining the proper speed for a given piece of work, and incidentally for determining the wheel best adapted to it, is by experimenting until the desired results are obtained. This does not necessarily mean, however, that whenever a new piece of work is to be ground, considerable time must be wasted, as the speed adjustments are easily made, and besides, experience will soon teach just what the proper combinations are. As the wheel is diminished in size, it appears to get softer, even though the peripheral or surface speed is maintained. This wear is due to the fact that the grit of a small wheel is in contact with the work oftener owing to the increased number of revolutions necessary for the same surface speed.

It should always be remembered that the one thing to be sought after is maximum production. If when choosing a wheel, for example, one too hard for the work is obtained with the idea of reducing the wheel wear, the corresponding reduction in the output will much more than off-set the increased expense for softer and more rapidly wearing wheels.

* With Shop Operation Sheet Supplement.

The wheel wear, however, should be considered, and, as it is dependent upon the work speed, the vibration of work, and depth of cut, these should receive the careful attention of the operator. When certain combinations of speed, feed, etc., have been found correct for a certain kind and size of material, it is advisable to record this information for future reference, for while such data may not always be applicable, owing to a difference in the grade of the material, it will, in many instances, enable one to save considerable time. A speed indicator or revolution counter is a useful tool for determining the proper speeds, especially when used in conjunction with a table giving the number of revolutions and the corresponding peripheral speeds for different diameters. The side feed of the wheel (or of the work) per revolution of the work, and the depth of cut, depend largely upon the construction of the machine. Grinders of the old type were intended for high work speeds with slow side feeds; with the modern machine, the work speed is low, but surfaces are ground rapidly by using wider wheels having side feeds of ¾ to ⅞ of their width for each revolution of the work, except for finishing cuts when reductions in side feed are usually made.

Those who read the description of the Landis grinder in the April issue will remember that the grinding wheel of that machine is traversed back and forth past the work, which remains stationary as far as axial movement is concerned. With the machine shown in the accompanying engraving, which is made by the Brown & Sharpe Mfg. Co., this order is reversed, the work and the table *A* moving longitudinally while the revolving wheel remains in a fixed position. This machine is also of the universal type, which, as before stated, is adapted to a wide range of work. The traverse of the

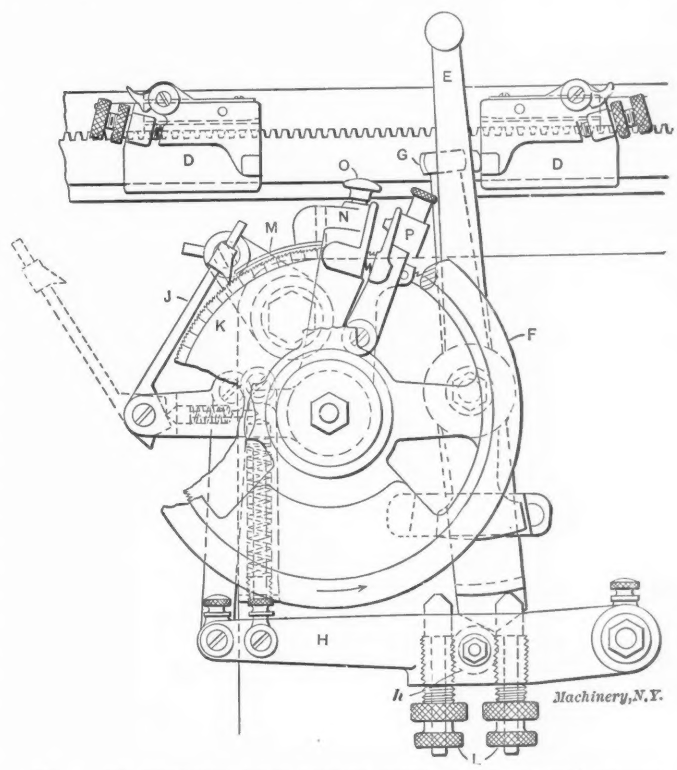


Fig. 2. The Mechanism which feeds the Grinding Wheel at Each Reversal and automatically disengages the Feed when a Predetermined Amount has been ground

table and the rotation of the work spindle may be started and stopped (on the latest design) by the lever *B* to the left. The wheel *C* to the right is used for moving the table back and forth by hand; when so used, the knob *c* is pushed inward. This knob is pulled out when the table is to be moved automatically, and pushed in when such movement is to be stopped. The dogs *D* regulate the stroke of the table, the movement of which may be reversed at any point by the lever *E*. By rotating the wheel *F* in different directions, the grinding wheel is moved to or from the work. The mechanism seen just back of this wheel is that of the automatic cross-feed. The way in which this feed operates will be more clearly understood by referring to the detail Fig. 2. At the

same time that the dogs *D* strike the lever *E*, thus reversing the table movement, the lever *G* is also actuated, which, through the roll *h*, operates the lever *H* and the pawl *J*. If this pawl is in mesh with the ratchet wheel *K*, the grinding wheel will be fed forward an amount depending upon the position of the screws *L*, which come against a surface on the lever *G*, thus regulating the upward movement of lever *H* and, consequently, the movement of the pawl at the end of each stroke. This automatic feed will continue at each reversal, until the shield *M* (which is attached to the head *N*) intercepts the pawl *J*, and prevents it from engaging with the ratchet wheel *K*. Thus by changing the position of the head *N*, the machine is set to grind any predetermined amount.

For example, we will assume that the automatic feed is to be set to grind the body *b* of the hardened bearing, illustrated in the Shop Operation Sheet accompanying this issue, to exactly four inches. After the machine is started and the stroke properly adjusted, place the pawl *J* in the position indicated by the dotted lines, and then move the wheel *F* in the direction indicated by the arrow, until the wheel is almost in contact with the work. Stop the stroke of the table by pushing in the knob *c* (Fig. 1), and set the pawl in the position shown by the full lines. Raise the latch *O* and move the head *N* around the periphery of the ratchet wheel until the point of the shield *M* has just passed the tooth occupied by the pawl, which will then rest upon the shield. Now when the table stroke is started, press the thumb-latch *P* until the grinding wheel begins to cut. Stop the stroke so that the wheel will be at the foot-stock end, and measure with a micrometer the diameter of the part ground; then press the latch *P* once for each one-quarter of a thousandth to be removed. If, for example, the body *b* measured 4.003 inches, or 0.003 inch over-size, the latch would be pressed twelve times, thus moving the shield *M* far enough away from the pawl to allow the latter to continue feeding until 0.003 inch is removed. The wheel should be stopped at the foot-stock end, as before, when the density of the sparks is about the same as on the cut taken prior to the first measurement. When the work is to be removed, throw out the pawl *J*, and, without changing the position of the shield, turn the wheel *F* to the right about one revolution. When a new blank is in position, the wheel *F* is turned to the left until the grinding wheel begins to cut, when the pawl *J* is again placed in mesh with the ratchet wheel. If, when the feed is automatically disengaged, the work is oversize, due to wheel wear, the latch *P* is pressed once for each quarter of a thousandth reduction required. It will be seen that with the automatic feed the wheel is fed inward, in unvarying amounts at each reversal. This regularity of feed has a decided advantage in that it increases the "sizing power" or the uniformity of the wear of the wheel, which is essential to the rapid production of duplicate parts.

All work that is ground on centers should be supported by suitable rests or steadies, as their use will permit greater feeds and also increase the sizing power of the wheel. If a piece be long and slender, such support is indispensable, and even for work which is short and rigid, rests are desirable to absorb the vibration which increases wheel wear and affects the quality of the work. These rests or supports are fastened to the table of the machine and are equipped with shoes of wood or soft metal, which bear against the piece being ground. The number and position of the rests depend on the form and diameter of the work; a distance between each rest of from 6 to 10 times this diameter will be found satisfactory for piston-rods, shafts and similar parts.

At the point where the wheel is in contact with the work there is considerable heat generated, consequently it has been found necessary, in most cases, to flood the grinding point with a copious supply of water. The pipe for this purpose is seen attached to the wheel-guard in the accompanying illustration. Such a cooling medium is very essential when grinding work revolving upon centers to prevent the radiation of the heat generated at the point of contact, for without an equable temperature is maintained, the part being ground will bend towards the wheel, owing to the elongation on that side; in other words, its axis will be continually changing, and, obviously, inaccuracy will be the result. This effect is even more pronounced when tubes are ground without water, or with an inadequate or intermittent supply, as there is less mass to absorb the heat.

* * *

PRACTICAL TEMPERS FOR TOOLS

J. R. S.

This list of tempers was determined by practical shop tests of the tools mentioned. A record was kept of the number of pieces machined before the tool required sharpening or renewal, and the most satisfactory temper adopted. A thermometer was used to determine degrees of heat, and mutton tallow for the bath.

Degrees F.	Class of Tool.
495 to 500	Taps ½ inch or over, for use on automatic screw machines.
490 to 495	Taps ½ inch or over, for use on screw machines where they pass through the work.
495 to 500	Nut taps ½ inch and under.
515 to 520	Taps ¼ inch and under, for use on automatic screw machines.
525 to 530	Thread dies to cut thread close to shoulder.
500 to 510	Thread dies for general work.
495	Thread dies for tool steel or steel tube.
440 to 445	Circular thread chaser for use on lathes.
525 to 540	Dies for bolt threader threading to shoulder.
460 to 470	Thread rolling dies.
430 to 435	Hollow mills (solid type) for roughing on automatic screw machine work.
450 to 455	Hollow mills (solid type) for use on the drill press.
485	Knurls.
450	Twist drills for hard service.
450	Centering tools for automatic screw machine.
430	Forming tools for automatic screw machine.
430 to 435	Cut-off tools for automatic screw machine.
440 to 450	Profile cutters for milling machine.
430	Formed milling cutters.
435 to 440	Milling cutters.
430 to 440	Reamers.
460	Counterbores and countersinks.
440 to 450	Fly-cutters for use on the drill press.
480	Cutters for tube or pipe-cutting machine.
430 to 440	Dies for heading bicycle spokes.
430	Punches for heading bicycle spokes.
430	Backer blocks for spoke drawing dies.
400	Drawing dies for bicycle spokes.
460 and 520	Snaps for Pneumatic hammers—Harden full length, temper to 460 degrees, then bring point to 520 degrees.

* * *

IDENTIFYING SMITHS

Statistics show that 1.1 per cent of electrical engineers are named Smith. That is, out of every 100 there will be a little more than one Smith. In the office force of a large corporation it often happens that there are so many Smiths holding positions of responsibility that some special means must be taken to identify them. The Crocker-Wheeler Company, manufacturers and electrical engineers, recently had considerable trouble at their main office, at Ampere, N. J., owing to the impossibility of getting their delivery boys to distinguish between the many Smiths there employed. Almost invariably one Smith would receive papers intended for another. This difficulty has been satisfactorily solved by posting on its various bulletin boards the following:

IDENTIFICATION TABLE OF SMITHS AT AMPERE

Initials.	Dept.	Complexion.	Stature.	Characteristics.
J.M.S.	Engineering	Dark	Short	Snappy but smiling
V.T.S.	Engineering	Dark	Long	Handsome and melancholy
L.P.S.	Drafting	Light	Tall and stout	Chubby and angelic
R.W.H.S.	Drafting	Light	Short	Unshaved and grumpy
F.W.S.	Laboratory	Dark	Short and slender	Very nervous
D.S.S.	Sales	Sparse, mixed	Thin	Wide-eyed and serious

(N. B. Shop Smiths will hereafter be numbered.)

* * *

Another feat in wireless telegraphy worth noting is that of the Japanese steamer *Aki Maru*, which, during a recent voyage between Japan and the United States, was in constant communication with land during the whole distance of 4,240 miles. For over 2,100 miles the steamer kept up communication with the Marconi station at Yokohama, and for the remainder of the voyage she was in communication with Seattle.

CYLINDRICAL GRINDING*

It is probably true that there is more misunderstanding among engineers and workmen in regard to cylindrical grinding than in the case of any of the other mechanical arts. Nearly every operator has a different theory; and each maker of grinding machines has his own method of grinding. There is confusion of ideas which can be cleared up by pursuing the investigation to the end. Don't take anything for granted. When you shall come to consider the commercial side of cylindrical grinding, no doubt the first argument you meet will be this one, which is brought forward very often by those who have not pursued the subject to the end. The argument is that, "It cannot be possible that metal can be as economically removed by a grinding wheel with delicate, microscopic cutting points as with a massive steel tool. Metal ground into powder cannot be as economically removed as with a tool that cuts off great chips."

Relative Time Required for Finishing by Turning and Grinding

A shaft 6½ inches diameter, 10 feet long, rough turned, cheaply to within about 1/32 inch of the required finish size, can be finished straight, round and to size by turning with a tool that cuts off a chip removing the 1/32 inch from the diameter and leaving a good surface that requires some filing and polishing with emery cloth, and the time required to thus finish the shaft to a limit of 0.0005 plus or minus, is from seven to eight hours, according to the quality of the cutting tool and of the material in the shaft, and to the skill and ambition of the workman. To remove the 1/32 inch from the diameter and finish the shaft to a limit of 0.0005 inch plus or minus by the grinding method, with a modern grinding machine, requires from one to two hours according to the ambition of the operator, and the finish is superior to the other method. Here is a case where the cutting of the material to a powder with microscopic cutting points was more economical than was the steel tool cutting a chip large enough to be seen and handled.

To be sure, the cutting points of the grinding wheel are small, but in this case there are approximately 1,086,171 cutting points, that cut one thousand times per minute, making, approximately, 1,086,171,000 chips per minute. Although these chips are small, they are essentially the same as cuttings from a steel tool.

The statement that it requires enormous power to grind steel to a powder, while cutting it into larger chips does not, should have careful thought. In the case of the 10-foot bar we use an average of approximately eight horse-power from one and one-half to two hours when grinding the finish cut. When turning to finish, we use about two horse-power from seven to eight hours. In the case of the 10-foot bar we required a nice surface and accurate measurements to a thousandth or less, and in both the lathe and the grinding machine we removed 1/32 inch more or less from the diameter. The production of such a grade of work when removing 1/32 inch more or less, shows greatest economy by the grinding method. When, however, the surface can be very rough and the diameter may vary within much larger limits, a steel tool cutting deeply will remove the same amount of metal in shorter time. If the object is simply to remove a certain number of pounds of metal, turning it off with a steel tool is cheapest. But as we know, nearly all round work must have accurate, or approximately accurate diameter, and from approximately smooth, to very smooth surface. The great majority of round work must finally have a better surface and more accurate dimensions than can be obtained with a steel tool, when it is cutting at sufficient speed and depth to enable it to remove material faster than by grinding. Therefore, the limited amount of material that is removed by the finishing operation on accurate, and approximately accurate work, can be more economically removed by grinding than by turning.

Relative Cost of Grinding and Lathe Work

There are also cases when work not requiring a smooth surface may be more cheaply ground than turned. A case that illustrates this is that of bridge pins, which were from 12 inches to 8 feet long, and from 3 inches to 18 inches diameter. These pins are roughly turned from the billet to within 1/32 or 1/16 inch of the required diameter, and then by another, or sizing cut, are completed. The limit of variation from size is 0.010 inch; if the turning tool is made to cut the right diameter at the starting end, the cutting edge of the tool must not wear off quite 0.005 inch when doing the work of removing the steel from the entire length of the pin. Now, in order to ensure that the tool shall not wear away enough to cause an error beyond these limits, it becomes necessary to revolve the work so slowly that the same results can be obtained more quickly by grinding, although the surface may be far from smooth. Grinding is accomplished by a number of rapid cuts, and during the final or light cuts, the grinding wheel does not wear at all, so that we are enabled to produce work of uniform diameter regardless of the length. We are now prepared to grind work up to 22 feet long to a limit of 0.0005 plus or minus.

While practically all round work is turned before grinding, there is a portion of such work that is most economically ground without turning. Owing to certain shapes, or structural weakness, it sometimes becomes difficult to turn; in such cases grinding is more economical than turning. An extreme case of this kind is that of a shaft, or bar of steel, 9/16 inch diameter and 10 feet long, with 1/16 inch to be removed from the diameter to produce an accurate ½-inch bar within a limit of 0.0005 inch plus or minus. It is easy to understand how difficult it would be to turn this bar. We, however, find it very easy to grind such a bar to the limits, and in short time. The roughing cuts that take the place of the turning easily remove the stock to within a few thousandths in about ten minutes, while hours would be consumed in turning such a bar to even coarse limits.

Advantage of Grinding Slender Work

Automobile crank-shafts are of such shape that certain portions of them are difficult to turn rapidly, and at the same time secure accuracy. Therefore we are enabled to grind the pins and short bearings direct from the drop forging in less time than we can turn them, and we secure better work. The long, frail crank-shafts for agricultural machines are also very difficult to turn rapidly, and at the same time secure good work. Many of these shafts are 7 feet long by 1⅝ inch diameter of stock, with bearings and pins reduced to 1 5/16 inch diameter. We find it most economical to grind all short bearings and pins without turning, while we find it best to first turn the long part at one end, grinding it afterward.

In the case of slender work that springs badly when it is turned, we can, many times, grind the same work more quickly than it can be turned and ground; because, when grinding off the material, the spring is ground out as it occurs, owing to the many cuts, or passes, of the grinding wheel; while when it is turned, with one cut over, it must be straightened before the finishing cut is taken. It is true, however, that the majority of work should be turned before grinding. I have been quoted as saying that we "grind without turning." I never said so. I did say, as I have done here, that *sometimes* we grind without turning, but *usually we do not.*

Poole Form of Cylindrical Grinding Machine

The earlier attempts at cylindrical grinding were made by mounting grinding wheels on the carriages of engine lathes, and there are those to-day who innocently suppose that the engine lathe produces perfectly cylindrical work, and that they have simply to add a grinding wheel to get a smooth surface on an otherwise perfect cylinder. This was proved to be untrue some thirty years ago, and I trust you will not lose any of your valuable time attempting to secure perfect work with turning lathes. Mr. J. Morton Poole, of Wilmington, Delaware, discovered that it was impossible to secure perfect cylinders by grinding with wheels on engine lathes, and, as a result of his study of the problem, the J. Morton Poole grinding machine was invented in the year 1867.

Mr. Poole's invention was unique, in that it enabled him to grind rolls of perfectly uniform diameter from end to end, regardless of the imperfections of the traversing carriage

* Abstract of address made by C. H. Norton, president of the Norton Grinding Co., Worcester, Mass., before the third-year class in mechanical engineering at Columbia University, April 16, 1907. For note on these lectures, see "Elements of Machine Manufacture," by Fred J. Miller, April, 1909.

ways. His invention came at a time when the art of scraping to master plates, and master straight-edges, was practically unknown, and when mechanics had little if any idea that such perfection could be obtained; much less maintained for any considerable time; also when few could appreciate the difference between the results he obtained and those obtained by the ordinary methods. The Poole machine, however, depends for success upon the use of *two* grinding wheels; one on either side of the work, and has, therefore, limited application. It has always been used for roll grinding. (See MACHINERY for January, 1897, and February, 1901.)

The modern grinding machine has ways that secure perfect work with a *single* wheel, thus giving the machine a wide field, covering all work that revolves on its axis, whether rolls, small or large, shafts, spindles, piston rods, work long or short, large or small, and having one single diameter, or many sizes on the same piece. The Poole machine gave accuracy. The modern machine, if rightly constructed, gives both accuracy and large production. Having but one wheel, and being open toward the operator, it is conveniently operated, and work is quickly placed or removed. I make this comparison not to depreciate the Poole machine, for I consider it one of the most important inventions in the development of the art. I wish, however, to have you realize that the development of the art of scraping, and straight-edge making, has made possible the use of very massive, long grinding ways that are really straight, and will remain straight for years. That such a thing was unknown when Mr. Poole made his very valuable and original invention to obtain perfect cylinders without perfect guiding ways.

The Lathe not a Perfect Finishing Machine

One of the most important facts in connection with cylindrical grinding for the young engineer to get clear in his mind is that all perfection in this world is relative, and that this is most certainly true of cylindrical grinding. This being true, to what in the mechanical world should he turn to fix the relation when deciding upon the quality of cylindrical grinding for the various uses it is intended? Why, most certainly to the lathe; because the grinding machine is no more and no less than a grinding lathe. Now, if its product is an improvement on the product of the ordinary lathe, then it has proved its right to the field. The lathe was never a polishing and buffing machine; neither was it a lapping machine. We used its centers and spindle on which to revolve work while we filed and polished, or lapped it; but there was nothing about the lathe that contributed in any way to the quality of the filing, lapping or polishing; that was a matter of hand work entirely. Therefore, when we wish to judge as to the merits of grinding, we must compare it with turning alone, not with turning, filing and lapping. Now, if we can, with the grinding machine, take the finishing cut of the lathe in less time than the lathe, and at the same time produce a better surface and nearer absolute cylindrical perfection, then are we warranted in adopting the grinding machine in place of the lathe for all finishing cuts, or sizing operations. If occasionally we require an absolutely perfect cylinder, we must lap it in addition; and the grinding machine, if well designed and constructed, is a perfect lapping machine also. We should not, however, expect perfect lapped work from any grinding wheel. We can, by taking time enough, produce a polished surface with a grinding wheel, but the same time, spent with a genuine lapping wheel, would produce more perfect work. Glossy surface by grinding wheels means imperfect cylinders. We can secure the closest approach to perfection by the use of grinding wheels that cut without perceptible pressure; thus they must be soft or free cutting, and, therefore, produce a surface without much gloss. He who desires really round work with uniformly distributed contact over its entire area, should use free-cutting wheels of broad face; and the truest work will show, not a bright, glossy surface, but a good surface and broad feed lines, when rubbed strongly through a round, straight hole; but no feed lines before such rubbing.

All cylindrical grinding by whatever method will show lines of cut and feed when rubbed in a round hole or when lapped in any other way. There is a difference between a cylinder with uniformly distributed contact, when tested in a perfectly round hole; and a really *perfect* cylinder. A really perfect cylinder is one whose surface molecules are every one the same radius, or all touch the inner surface of a perfectly round ring when it is passed over the entire length of the cylinder. Such perfection can be obtained, approximately, by some form of lapping. Any one who shall look for such perfection from grinding, will be forever disappointed. Grinding, however, does give us vastly more points of contact than turning or even careful filing to a micrometer and polishing with emery cloth—the method used by those who do not grind.

Broad Cuts Produce Most Accurate Surfaces

Feed lines are caused by the "lap" of the wheel cutting twice on that portion of the surface, i. e., we do not traverse quite the exact width of the wheel at each revolution, but as near as safe and avoid ridges. The wheel cutting twice over this narrow place leaves a different grain, therefore a different color, even though the measurable diameter there be no different than elsewhere. In my apprentice days, we used to plane all work with a very fine feed, and considered the best work that which showed no feed lines. But Mr. William Sellers showed us that the surfaces we produced that way were not perfectly flat surfaces, while he produced a more uniformly distributed contact, tested with a perfect surface plate, by using a wide tool and a broad feed line. The surface he produced was *not so smooth* but it was nearer a perfectly flat surface. No one disputes his theory to-day; all plane with a coarse feed.

Rough Turning Desirable for Economy in Grinding

Another fact in connection with cylindrical grinding that it is well for young engineers to get clearly fixed in their minds when leaving college and starting out in practice, is this: that to secure the greatest economy by the use of grinding machines they should pay less for all turning than when the work is to be finished in the lathe. With well constructed grinding machines, the coarser the turning the quicker the grinding can be done. It is no longer necessary to turn either smoothly or correctly to size. A variation of 1/32 inch more or less on large work is of no moment, and on small work a variation of 1/64 inch more or less is permissible, and the surface may be very rough in all cases.

A large part of the economy is secured by cheap turning. You will find it difficult to secure such turning, owing to prejudice, ignorance, opposition, and fear on the part of many workmen, foreman, and superintendents. As engineers, you will find the greatest problems are not mechanical, but that the solving of the human problems will require everlasting study, and to secure the full economy by grinding you will need generalship in a high degree to get work turned rightly for grinding. All traditions must be upset if work is rightly turned. I think there are few places where grinding machines are used that the turning is done as cheaply and roughly as it should be. I have never been able to secure what I desired in this respect.

About the relative cost of finishing to size by turning or by grinding, it varies greatly in different works, but the grinding method shows a saving according to the sympathy and intelligence that goes into the enterprise and the nature of the work. There is much opposition to grinding in some places, where the saving is small; but where a systematic and intelligent effort is put into it, the saving is large. A manager recently told me that the saving was sixty per cent over their former lathe method of sizing and finishing.

There are not enough good operators to run machines now installed, and the success of these machines is held back owing to the large amount of ignorance of grinding machines and grinding operations on the part of foremen, superintendents and managers. The art is yet new and invites the aid of young engineers in placing it in a still more useful position in the world's service. Cylindrical grinding is, however, firmly entrenched in this country, and, in many lines of manufacture, all round work is ground. All first-class automobiles have every round part ground; all sewing-machines, typewriters, phonographs; large machinery is also ground to a considerable extent.

The cylindrical grinding machine has taken its place as a practical metal-cutting tool to be used by progressive manu-

facturers as a labor saver; and manufacturers to whose attention its possibilities have been brought by practical demonstrations, have accepted it as a settled method of sizing cylindrical work.

* * *

PAT'S PROMOTION

C. TUELLS

Just how Mr. Roland Thompson came to be in charge of the foundry at the Morton Steel Company no one seemed to know. In some ways he was admirably capable: he had a prepossessing appearance, his personality was wonderful, and his command of the English language would have enabled him to convince anyone that black was white. As a salesman he would have been a tremendous success, but his lack of knowledge of the foundry business made his success in that line rather dubious. In a nutshell, Mr. Thompson's "bluff" was his stock in trade, and whether it was a case of

"Pat is still trucking castings from the foundry"

refusing his best molder a raise or explaining to the super why the production was not greater, his "bluff" always stood by him.

Pat Morrison was the laborer who trucked the castings from the foundry to the machine shop at one dollar and fifty cents per day. It kept him hustling all day to get the finished castings off the foundry floor, and when the foundry was busy the casting pile looked much like a mountain to poor Pat, for it was his daily task to remove that mountain. It was kind of a lonesome job, too, for there were few to talk with on his trips to the machine shop, even if he had the time, so he had plenty of opportunities to think over his trials and tribulations.

One morning when his mountain of castings looked larger than ever he evolved the idea that his job was worth more than fifteen cents an hour, and the more he thought it over, the heavier his truckloads of castings became, and the surer he became that he was right, so about half-past ten he could stand it no longer, and marched up to the foundry office.

Mr. Thompson was just finishing a well-worded letter to the super telling him how hard the foundry was working to ship a rush order of castings, when Pat came in, and stating his case asked for a raise of five cents an hour, which would make his wages two dollars per day. After listening gravely to Pat's request, Mr. Thompson assumed one of his most patronizing airs and addressed Pat as follows:

"Mr. Morrison" (before he had always been Pat), "I have had your case under consideration for some time, and I have decided to promote you. From now on I want you to take entire charge of trucking these castings from the foundry to the machine shop; I want you to personally attend to every detail of this important work, to see that they are properly loaded, safely carried over and deposited in their proper places, and in fact, devote your whole time to this work. Now, if I can safely entrust this great responsibility to your care you can readily see how much better off you will be than if I should give you an increase of a few cents an hour."

As he proceeded Pat commenced to look important, and as he finished, thanked him for the "promotion" and walked out of the office, his head high and chest thrown out, his thoughts concentrated on "Mr. Morrison" and his new job, which was simply his same old job at the same old pay,—trucking castings at fifteen cents an hour, described in flowing terms.

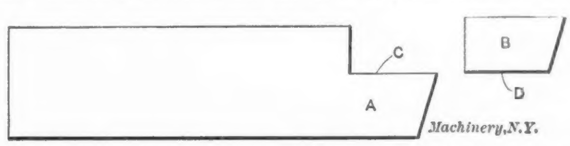
Pat is still trucking castings from the foundry, and for the same money, but he is doing some heavy thinking as a side line. Through the policy of Mr. Thompson the foundry office is being looked upon as a magnificent example of "bluff" by the rest of the works, and over in the machine shop there is tacked upon the wall a little parody that, if we except Pat, seems to fit the foundry situation to a tee.

Everybody works but the foundry,
  They sit around all day.
Always writing letters,
  Expect to ship next day.
Customers keep on waiting,
  New stories we must tell.
Everybody works at the foundry,
  Yes, they do, like ——.

* * *

WELDING A HIGH-SPEED STEEL CUTTER TO A MACHINE STEEL BODY

A method for welding high-speed steel cutters to machine steel bodies or shanks has been patented by Mr. Paul A. Viallon, 102 Avenue Parmentier, Paris, France. The process, as described in the *Mechanical Engineer* of January 29, is comparatively simple and inexpensive, and if it should prove successful, would undoubtedly be valuable in the metal trades. The machine steel shank is indented about as shown at *A* in the accompanying illustration, and the high-speed steel cutter may have the appearance shown at *B*. The surfaces *C* and *D* are well finished, and the shank and the cutter are both heated to a cherry-red heat. Solder is applied on the surface *C*, the cutter is placed on it, and the two parts are forced together by heavy pressure. This operation has the effect of melting the soldering material and producing adherence between the cutter and the shank. The tool is now carefully put into the fire, from where it is withdrawn when it has reached a yellow heat (2,000 to 2,400 degrees F.). The



High-speed Steel Cutter to be welded to Shank of Machine Steel

weld is now completed by hammering at the top of the tool, first lightly, and then with heavier blows. The tool is permitted to cool slowly, and may then be dressed and finished and re-heated to the required hardening temperature for high-speed steel, and hardened. When the welded-on part of high-speed steel is worn down so that it must be replaced by a new cutter, the old cutter may be detached without injuring the machine steel shank, by heating the cutter and the shank at the joint, and then removing the cutter by pressure applied on its side.

* * *

Coke for locomotive fuel is being tried by the Illinois Central R. R. for the purpose of eliminating smoke at its Chicago terminal. It is stated in the *Engineering Record* that the results obtained indicate that the use of coke will be successful, but the trial has been conducted for so short a period that no general conclusion as to the relative cost of the coke as fuel can be drawn. The city has demanded the electrification of the company's Chicago property, but the favorable outcome of these experiments may lead to the adoption of coke fuel, at least for some time to come.

* * *

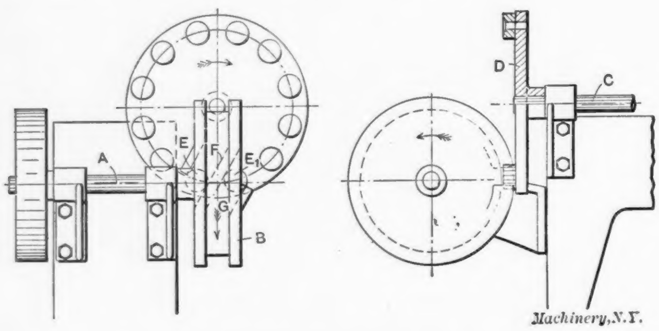
The New York Central established a new record from New York to Chicago with the Vanderlip special, which made the run March 26-27 in sixteen hours and seven minutes, including twenty-four minutes allowance for six stops to change engines.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

A SEMI-GENEVA DRIVE

To drive a shaft continuously from another shaft also running at a constant speed, the two shafts being placed at right angles to each other and in different planes, is an every-day experience, and can be done by belt, worm gears or spiral gears; but to connect these two shafts so that the driven shaft makes only a part of a turn and then comes to a positive standstill while the driver still runs, is probably out of the ordinary. The illustration shows a drive of the latter type (which was adopted as a feed mechanism on an automatic machine) which worked satisfactorily.



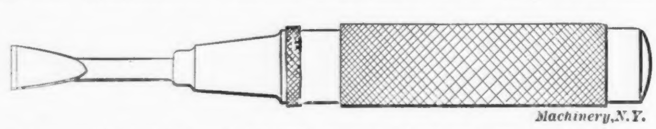
An Intermittent Drive for Two Shafts at Right Angles to each other and in Different Planes

On the outer end of the driving shaft *A* is a cam *B* having a face groove, open on both sides. On the outer end of the driven shaft *C* a disk *D* is fastened, on which are mounted rollers *E*. As the cam *B* revolves in the direction indicated by the arrow, the cam surface *F* pushes the roller *E* over to the left, causing the disk *D* to turn, and the roller E_1, which is pushed over to the central position by the cam surface *G*, is engaged. Roller E_1 remains in the groove until the cam has made one revolution, when it is also disengaged, another roller at the same time entering the groove, and so on.

This drive takes the place of a "Geneva movement" which, in this case, would be quite difficult to arrange. E. P.

ANOTHER USE FOR THE AUTOMATIC CENTER PUNCH

The automatic center punch, though sometimes used merely as a novelty, is nevertheless a very handy and time-saving device when applied to the marking of a large number of holes, as when laying out press tools. The tool's usefulness does not end here, however, for it may be used to even better advantage when equipped with a chisel tip, as shown in the illustration. One is sometimes in a very awkward



Automatic Center Punch equipped with a Chisel for Hand Graduating

position when a piece of work has to be graduated which cannot be done in a machine, and when the only tools available are a hand-hammer and chisel. With the automatic chisel we can avert that nervous moment between the setting of the chisel and the dropping of the hammer, which often proves so disastrous, as the eyes can be kept on the work, and the chisel easily held in the proper position. When a line needs to be made which is longer than the width of the chisel tip, it can be extended to any required length by setting a straight-edge in position and sliding the chisel along its edge, repeating the blows. E. W. H.

FISH-TAIL MILLS

About a year ago the writer had a cylindrical piece like the one shown in Fig. 1 brought to him with directions to put a slot through it as shown. Along with the work came the instrument shown in Fig. 2, which was introduced by the foreman as a "fish-tail mill." I had never seen one before, and after inserting it in an ordinary milling machine and living right with it for some hours, I heartily desired never to see another. The cutter speed was about forty feet per minute, the cut three-thousandths and the feed about seven inches per minute, or thirty-thousandths per revolution of the cutter. Since then there have been several jobs of splining and slotting to be done with fish-tail mills. Half a dozen of us took turns at one or another of them. The last one that came to me made me decide right off to get a cushion for my stool at the machine. There were 160 keyways three-sixteenths of an inch wide by an inch and a quarter long. I didn't get any cushion though, as it would have been conducive to undue levity among the kids, and, besides, I had something better. I took the mill shown at *A*, Fig. 3, and ground it as shown at *B*. I was then able to take a cut of five-thousandths instead of three-thousandths, and a table feed of twenty inches per minute instead of seven.

Of course, where spline millers are in operation everybody knows how to grind the fish-tail mills, but this was new to me and apparently not known to any of the several Yankee tool-makers who ground and used the mills at one time or another. The small mill I ground by hand, but the next one I shall grind square the same as any other end mill by using the cutter grinder. The corners and centers are, of

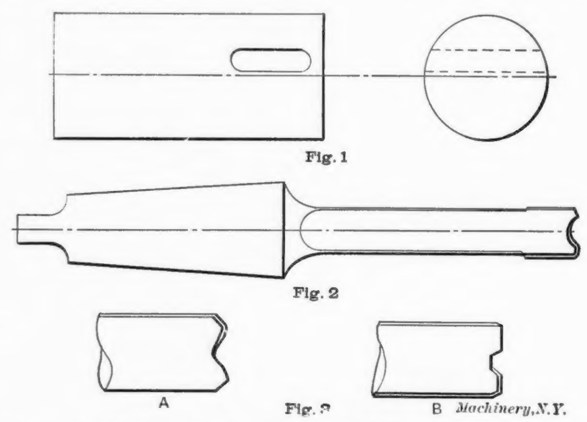


Fig. 1. The Work Fig. 2. The Fish-tail Mill Fig. 3. Incorrect and Correct Methods of Grinding

course, touched off free-hand. A cutter like *B* makes chips instead of crumbs, and they say "You can tell a workman by his chips." J. C. T.

A CAM WITH SOME SPECIAL FEATURES

In Fig. 1 is shown an arrangement (which is not entirely new) for economizing space in a special machine. The general scheme is as follows: The drum cam *E*, which is pinned to its shaft, is required to turn 90 degrees while it moves lengthwise 6 inches, and to resume its original position as it returns. The cam is shown in its central position. When it is at the extreme left, the roller *A* is in the groove while the roller *B*, which is 3 inches to the right, is freely suspended. When the cam moves toward the right, the groove will engage the roller *B*, and, as the cam continues to advance, it will leave the roller *A* and move under control of the roller *B*. As the cam is 3½ inches long, and has a movement of 3 inches on each side of its central position, the entire space which it occupies is 9½ inches, while if a single roller were employed, the cam would be 6½ inches long and would require a space of 12½ inches for action; thus a saving of 3 inches is made. This arrangement causes extra wear in the cam groove to compensate for this, but extra grooves may be cut around the periphery of the cam when it is being made, and these grooves may be brought into use by resetting the cam on the shaft, when necessary.

In order to secure satisfactory results, it is essential that the rollers *A* and *B* be aligned properly in the path of the cam groove. It is the method of locating these rollers that

is of special interest to mechanics. The stud *W*, for the roller *B*, was located without difficulty directly over the center of the cam shaft. A ⅜-inch hole was then drilled in the bracket *H* as near the position of the stud *X*, for the roller *A*, as could be done easily. The spiral groove in the cam being cut and finished, the two rollers *A* and *B* were made and ground so that they could be crowded under pressure into this groove. The cam was then placed on its shaft under the bracket *H*, and the stud *W* set in position, holding the roller *B* in the

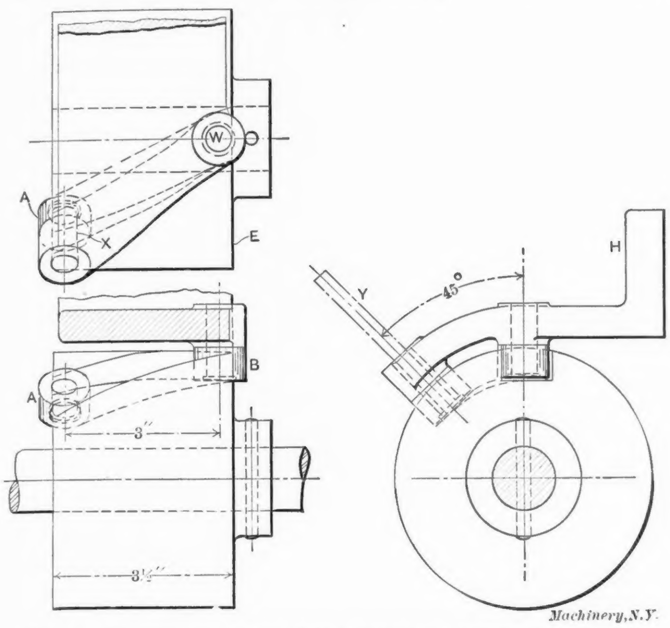


Fig. 1. Cam with Two Rollers which reduce its Longitudinal Movement

groove. The roller *A* was then pressed into the groove on the left side of the cam. Before this roller was placed in the groove, however, a 5/16-inch bushing was driven into the half-inch hole in its center. Into this bushing a test-bar, *Y*, of straight 5/16-inch drill rod, was carefully fitted. With the two rollers in position under the bracket *H*, an attempt was made to put the test-bar through the ⅜-inch hole (which had already been drilled in the bracket) and into the bushing in the roller. In order to do this, it was necessary to enlarge the hole at one spot with a file, after which the bar was set in the bushing. The assembled mechanism was then taken to the drill press, and, after some adjusting, the test-bar was brought to a vertical position directly under the drill press spindle. The bar was then removed, and a 7/16-inch counterbore with a long pilot which reached into the bushing in the roller, was used with care to enlarge the hole for the stud *X*. Proceeding in this way, changing counterbores

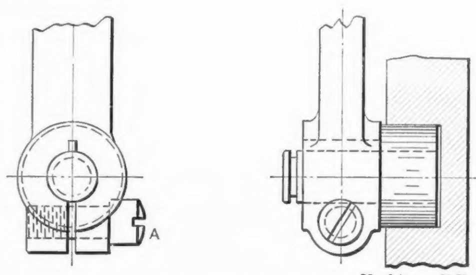


Fig. 2. Type of Cam Roller which is easily removed

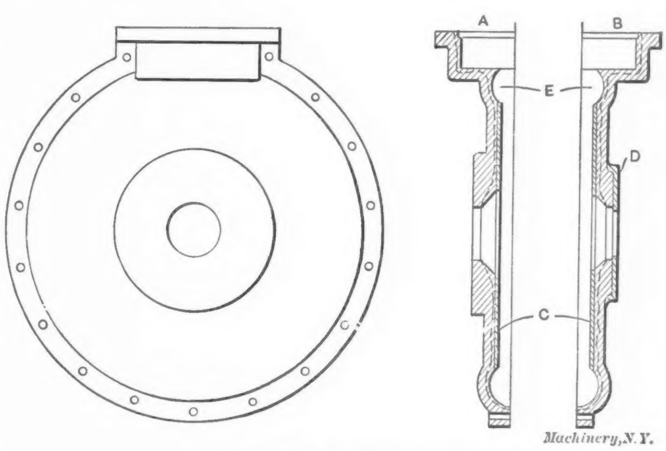
several times, the hole was finally reamed to size. The rollers were then ground to a good running fit, and reassembled in position. This method of procedure made the alignment of the two studs *W* and *X* perfect. It is unlikely that this result would have been obtained in any other way, except at a cost of much more time and effort.

In Fig. 2 is shown a type of roller stud which also is not new, but which is not in such general use as its advantages warrant. The sketch explains itself. When it is desired to remove a roller, the clamping screw *A* is loosened; the operator then places the end of the screw-driver into the groove in the stud and easily draws it out of the lever. This is a much simpler matter than is usually the case with the old type of studs which are held by set-screws. The screw generally makes a burr on the stud, which causes all manner of trouble for the machinist. The stud shown is especially convenient when soft rollers are used in the cam race-ways, as these, of course, wear much faster than hardened steel rollers. The practice of using soft, rather than hard rollers, is growing as it is being more widely realized that there is greater economy in frequently renewing cam rollers than in occasionally renewing cams. There are comparatively few cam movements which will not admit of some wear in the rollers, without serious inconvenience. HERBERT C. BARNES.

Brooklyn, N. Y.

SMITHERS' PATTERN EXPERIENCE

I dropped in on Smithers the other day and while there saw an iron pattern for a centrifugal pump casing which had been made from the old casting. Smithers said he had acquired considerable experience through that pattern, for while the casting was badly eaten away on the inside, as indicated by the dotted lines in the engraving, the outside was in good condition and so he thought he could save time and money by using the casting instead of making a new wooden pattern. The shrinkage did no harm, since one side of the pump wore out as soon as the other and the new halves were always finished and bolted together. As the flange on the casting *B* was smaller than the one on the casting *A*, he decided to use *B* for a pattern. Plugs were driven in all the bolt holes and the strips for the finished surfaces of the flanges secured to them. Holes were also drilled through the pattern to secure the wooden plate to make up the necessary thickness at *C*. The central holes were cored and a loose flange *D* slipped over the hub made the pattern right



The Iron Pattern for Centrifugal Pump Casing

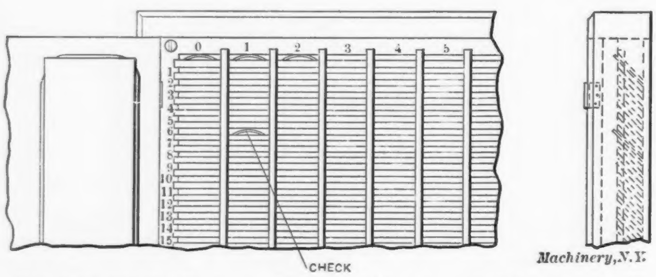
for casting *A*. Two core-boxes were required for the central openings. The irregular shapes at *E* gave Smithers some thought, but he decided to fill them with composition and hold this composition in place by means of wire pins. These were driven in holes drilled in the castings, and were cut off slightly below the surface of the finished castings. Now, Smithers knew that in a jobbing shop patterns did not always get the same careful handling that they do in manufacturing shops, and, as from time to time he would have castings made from this pattern he wanted a composition that would harden and would not crumble nor peel off. After looking over a large number of receipts he found one which he thought would answer the purpose. This called for 10 parts of iron filings, 3 parts chloride of lime, and enough water to make a thick paste. The formula says that if placed between surfaces under pressure it will harden in 12 hours, and the casting will break elsewhere than at the joint. Smithers thought that if it did that it would surely work all right on his pattern. Not being able to secure sufficient lime in town he sent away for it; then made up the mixture, and applied it to the pattern. At the end of 24 hours it was still as soft as ever; at the end of 48 hours, no better; and at the end of 72 hours he got disgusted and scraped it all out. Two or three weeks later he came across some

of it in the yard, and found that while it had dried it was simply a crumbly mass, with no strength. His pattern-maker wanted a chance to try his hand and made up a new mixture consisting of $3\frac{1}{2}$ parts Portland cement, $3\frac{1}{2}$ parts iron filings, 2 parts common sand, and 1 part common salt. This was thoroughly mixed together, and made into a thick paste by the addition of water. Smithers said this composition worked like a charm. It was slicked up smoothly, shellaced, and sand-papered, and made a fine-looking job. He showed me some of this composition, which was hard and seemed to have considerable strength. It stands the usage around the foundry, and also the handling to and from the pattern store-house. Smithers says that while the experience cost him something he was willing to stand for it, as the composition will come in handy on other similar jobs.

Covington, Va. WM. SANGSTER.

CHECK SYSTEMS FOR THE TOOL-ROOM

There are many tool checking systems in use in the modern machine shop, but those which are not complicated are more or less conspicuous by their absence. Tool checking plays an important part in the up-to-date shop; therefore the writer will endeavor to bring to light a very good method of procedure in handling checks to the best advantage. In some shops tools are given a certain classification letter or number. In this case the tools are numbered consecutively, in much the same manner as the shop blue-prints are. Fig. 1 will give an idea of the construction of the cabinet for the checks. There are ten vertical rows of slots which, as will be seen, are numbered at the top. By combining these numbers with those seen on the left-hand side of the board, different checks are located. For example, if we want check No. 61 we read down



Board for Keeping Tool-room Checks which are numbered consecutively

six figures on the vertical row to the left and move to the right under the row of slots with the figure 1 above. It takes less time to number the slots in this manner and the usual maze of figures generally found on the check boards is eliminated, thus facilitating the location of checks placed therein. The slots are at an angle of 45 degrees, as shown in the end view, so that the checks will stay in their respective places. The size of the slots will depend, of course, on the diameter of the checks, but the depth should be somewhat less than the diameter, to allow the checks to be lifted out easily. By using this type of board the tool supply man will have all checks under lock and key, and the tools given out under constant observation, so that the chances of their disappearance to places unknown is eliminated. L. H. GEORGER.

Buffalo, N. Y.

After having had an experience of more than twenty-five years in machine shops and in some of the largest factories in the country, I was surprised to read the article by Mr. Hadun in the March issue, where he states that he abandoned the check system whereby the workman has the check in his possession. In the following article I shall give a description of a system in use in the large supply room of a certain company, which has proved effective, and which may contain some points of interest.

When a new man enters the employ of this company, he receives a brass admittance check with his check number on it. This check is always in his possession and must be shown to the watchman at the door on entering. A white tag 1 7/16 inch in diameter (see Fig. 2) is received by the foreman of the tool supply room from the office. On one side of this tag is the man's name and admittance check number, on the other side is stamped the date when the check is received by the foreman of the supply room. On the check board there are a number of checks (usually fifteen or twenty-five) corresponding to the number on the admittance check. The number of checks found on the hook is then written on the white tag under the date. The new man must show his admittance check before he can receive his tool checks.

The check board shown in Fig. 1 is mounted on a ball-bearing so that it revolves easily. There are eight spaces, as shown in the plan view, each of which contains 200 hooks, making 1,600 in all. When a man leaves, he must return the number of checks charged to him on the back of the tag. If he does not have the required number and they are not found in the supply room, blue-printing room or jig room, he must pay for them. He understands this when he receives his check on entering the employ of the company. The attendant of the supply rooms enters the lost checks or tools on the tag, and the man takes the tag to the office; without this tag it is impossible for him to receive his money. When a man is transferred from one department to another, he receives a new admittance check, the old one being taken from him. He must return all checks, and if they cannot be found, the attendant charges those which are lost against the man on the old tag, which is sent to the office so that the loss may be taken from his pay. If at any time any of the lost checks are found, the money paid is refunded. A new tag is received by the foreman with the man's new admittance check number, and after dating and writing the number of checks that is on the hook on the tag as before, the man is given a new lot of checks.

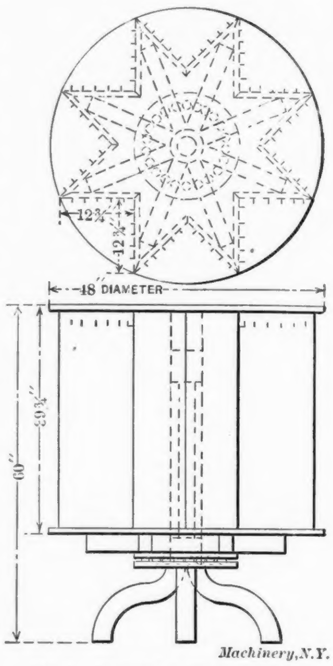


Fig. 1. Revolving Check Board

All tools, such as drills, reamers, taps, etc., are marked alphabetically, and a brass strip with the letters stamped on it and filled in with black shellac is tacked on the tool cases. There is also a hook under each letter to hang the man's check on. The advantage in marking the tools is this: a workman cannot return another man's drill, reamer, or any

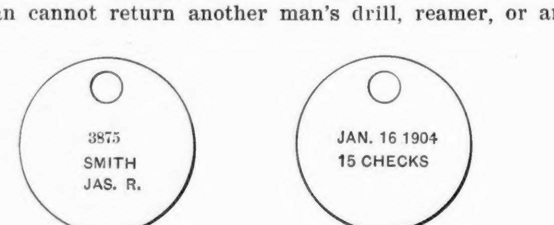


Fig. 2. Tag which is filed in the Tool-room, giving Name and Number of Employe, and Number of Checks in his Possession

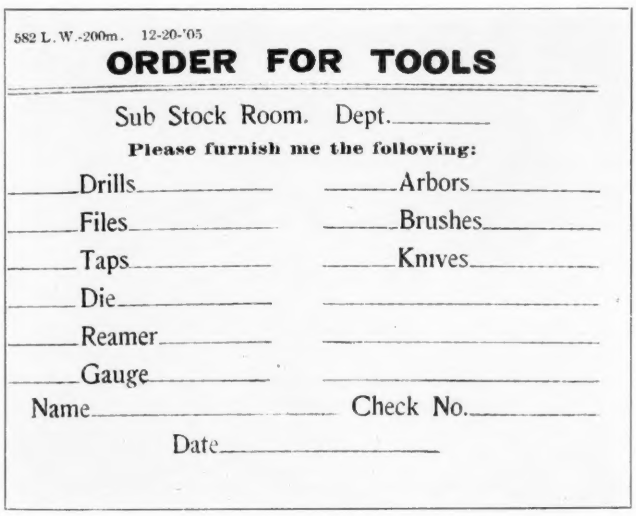
tool having another letter than the one on which his check hangs. When the men become acquainted with the system of marking the tools, they seldom bring in a wrong letter. If a workman loses a tool of any kind and does not remember the letter, he can find out what it is at the tool-room; then he has a perfect right to take the tool wherever he finds it and bring it to the tool-room and receive his check. Taps of all sizes are set on end in a hardwood block, three in a set, and the block is marked with a letter and placed in the case over that particular letter. The machine screw taps are arranged in a block with a full size drill, a tap drill, and two taps. Tags about one inch in diameter and of different colors are used for broken tools, lost tools, tools being repaired, and also for those that are sent out on the road with the erecting gang. The tool inspector's bench is located just

back of the delivery window, and all tools received are placed on this bench so that they may be inspected and any errors corrected before the tools are put away. All gages that are received at the supply room are tested on a Pratt & Whitney 80-inch measuring machine before being put in their cases.

Every four weeks each tool has to be accounted for, and on the Thursday morning of the fourth week a card is posted announcing that the following Saturday is check day. On this particular Thursday half-round checks are hung over the checks that hang on tools, and a wire clip is attached to the checks where a number hang on one hook, such as those used for bolts, straps and other such tools which are not lettered. As the tools are returned, the half-round checks and clips are put in a box, no account being taken of them. The different foremen are supplied with a printed form for the use of those workmen who cannot return their tools. This printed form must be filled out with the workman's name, check number, name of tool, and letter, and signed by the foreman. No account is taken of tools that are given out after the half-round check and clip are put on. The checking is done after one o'clock Saturday afternoon, as the factory stops work at noon. The first operation in checking is to write on a small slip of paper, the size, letter and check number of all tools on which a half check is found. The slip is then hung on each hook corresponding to the tool and number, after which the slips are collected and arranged in hundreds. The printed forms for the tools in use and the corresponding slips on which the different tools are checked, are compared and if found correct are put aside. Lists (with carbon copy) are then made out and a copy is sent to each foreman containing check numbers and list of tools charged to each workman under him, and these tools must be accounted for or the workman must pay for those which are lost. A list of all lost tools which are paid for in this way is kept in the office, and if a tool is found at any time, the office is notified, and the workman receives his money. The small number lost, however, was surprising when the men became acquainted with the system. ALBERT C. SAWYER.

Dorchester, Mass.

It is evident that Mr. Hadun, judging from his article on Check Systems for Tool Rooms in the March issue, has had considerable trouble in determining *the* system for checking tools. I have been up against the same proposition, but my conclusions are somewhat different from his. In the first system mentioned in the article referred to, each man kept his own checks. This, I think, is the most common method



582 L. W.-200m. 12-20-'05

ORDER FOR TOOLS

Sub Stock Room. Dept.______

Please furnish me the following:

____Drills____	____Arbors____
____Files____	____Brushes____
____Taps____	____Knives____
____Die____	
____Reamer____	
____Gauge____	

Name______ Check No.______

Date______

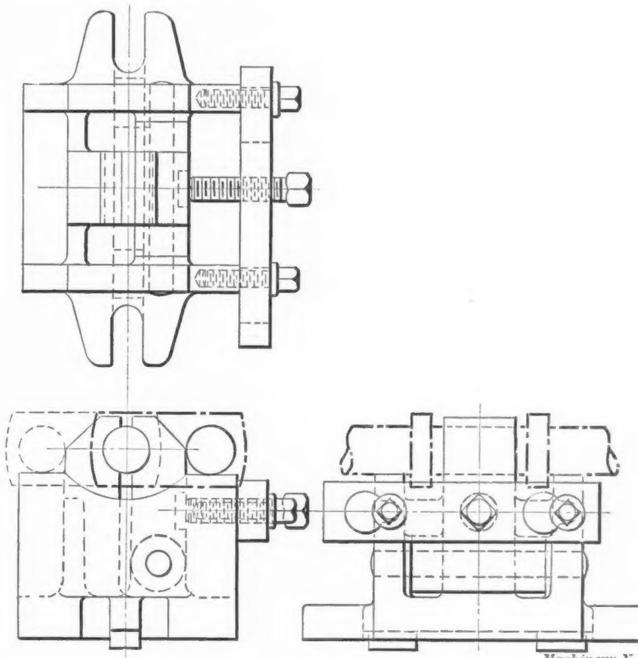
Printed Slips used by the General Electric Co. at Lynn, Mass., to insure the Return of Tools to the Supply Room

and seems to give the greatest satisfaction, all things being considered. When the workman realizes that in the event of his services being dispensed with his pay will be held up until all the checks are accounted for, he will see that his checks tally with the tools in his possession. If they do not, as a rule he will immediately take steps to see that the matter is straightened out, and usually, if taken in time, it is a simple matter. I have worked in many shops where this system is in vogue, and have yet to learn of an instance where a man used another man's check dishonestly. For one to count the tools and checks in hand in order to see just where he stands, is simplicity itself. I fail to see where the written slip has any advantage over the first system mentioned, as it is as easy to forget to have the slip removed from the card case as it is to ask for the check—then there is the extra expense. There are, however, some who prefer the printed slips and for those who do I show herewith the form used by the General Electric Co. in the tool room at Lynn, Mass. Each man is furnished with blocks of probably fifty, and as these are used, more are furnished at the tool room window.

Lowell, Mass. WILLIAM B. HILLIARD.

A MILLING FIXTURE FOR THE WEBS OF CRANKSHAFTS

The accompanying illustration shows a milling fixture intended for milling the webs of crankshafts on both sides at practically one setting. It will be seen that by using this fixture the webs will be milled at equal distances from the center on either side. The crankshaft is held in position by its center journal by a vise-like clamp. After milling one side,



Fixture for Milling the Webs of Crankshafts

it is only necessary to loosen the set-screw shown, and twist the shaft until it rests on the opposite side of the fixture. The set-screw is then again tightened, and the opposite side milled. When the shaft is to be removed, the two collar-head screws are loosened, and the strap on the right-hand side slid towards the right, which permits it to be pulled over the collars of the screws, and one of the jaws holding the crankshaft to be folded back so that the crankshaft can be taken out and a new one put in place. S. H. SWEET.

Bridgeport, Conn.

BLUING METALS

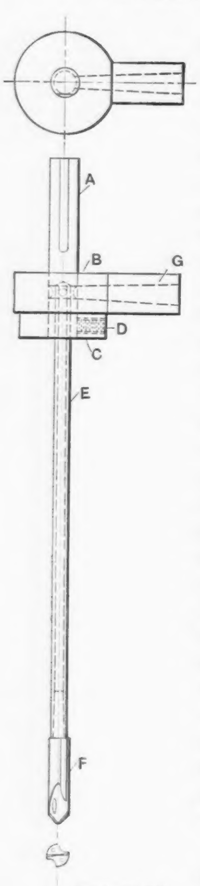
In answer to C. L. L.'s question in the March issue for a formula for bluing metals, the following method is submitted. A good color may be obtained on small articles by the following solution, which, while particularly intended for obtaining a gold color on brass, is frequently used for imparting a steel-blue color on brass or other metals. The solution consists of water, one gallon; sugar of lead (acetate of lead), four ounces; hyposulphite of soda, four ounces. The sugar of lead is dissolved in water previously heated nearly to boiling, and then the hyposulphite of soda is added. The solution has a milky color from the precipitated hyposulphite of soda, but it should not be filtered out. In order to get the best results, the solution should be heated to a temperature of 200 degrees F., or just short of boiling, when it turns black. When immediately made, the white precipitate in the

solution is fine and adheres to the articles being colored, but after heating for five or ten minutes it collects and settles to the bottom. It is then that the best results are obtained in coloring brass. After some time the solution does not work so rapidly and finally a new one has to be made up. A large quantity of work can be passed through, however, as the color is a mere film.

The brass to be colored should be cleaned in the usual manner, and may be polished and then dipped. The articles are immersed in the hot solution (nearly boiling) and carefully watched. It takes a few seconds for the first shade of color to appear and it is then very light. Soon a darker yellow forms and then a brownish gold shade is produced. The articles are removed as soon as the desired color is reached and should not under any circumstances be allowed to remain, as the shade rapidly darkens and becomes purple. By allowing to remain longer, a blue and finally steel black can be produced. Rinse first in cold, and then in hot water, then dry in sawdust. The articles are then lacquered.

Plainfield, N. J. JOSEPH WEANER.

TOOL FOR DEEP-HOLE DRILLING



Drill for Deep Holes

The line engraving shows a drill used by the Waltham Watch Co., which has proved to be a very useful tool for drilling deep holes. The feature of this tool is that the chips are carried away from the point of the drill by compressed air. Many of the machines in the shop are operated by compressed air, and for this reason it is very handy to apply the air for the removal of the chips as well. The drill shank *A* is held in the collet of an upright drill. The collar *B* has a running fit on the lower end of the shank. The air connection is attached to the lug *G*, projecting from the side of *B*. The collar *B* is held in position between the collar *C* and the end of the drill collet. The collar *C* is simply held by a screw *D*. The part *E* is a seamless steel tube extending into the shank *A* to the air inlet or groove around the shank, and is soldered in place. The shank *A* is solid above the air inlet. The drill proper is shown at *F*. This drill is provided with a taper shank soldered into the tube *E* and having a hole drilled through the taper shank connecting with two small holes in the drill point as shown in the end view. It is easily seen that the air supplied through the nozzle *G* to the tube *E* will exhaust through the holes in the point of the drill, and by this means the chips are removed.

These drills are commonly made of different lengths to drill deep holes in succession. The first drill is four inches long, the second eight inches, etc. Extreme care must be used to have the drill start central with the center punch mark for the drill. Holes have been drilled with this tool four inches deep in one minute through ordinary cast iron. The air pressure used is 35 pounds per square inch.

Waltham, Mass. FRANCIS P. HAVENS.

SAVING TAPS AGAINST BREAKAGE

Taps frequently break off while tapping out holes with a drill press, thus ruining the tap. A method which has proved its value for saving taps against breakage is illustrated in Fig. 1. The device is simply a safety pin which provides a breaking point that will give way or shear off when the tap gets stuck, before the strain is sufficient to break the tap, which will occasionally happen through carelessness or otherwise. If the drilled hole is too small, or if the tap reaches the bottom of the hole sooner than expected, the safety pin will shear off and thus save the tap. As shown in Fig. 1, the shank of the tap fits nicely into the bore of a sleeve and through both sleeve and shank is the safety pin, which is a light drive fit. The outside diameter of the sleeve is made to fit into the holder shown in Fig. 2. The sleeve is provided

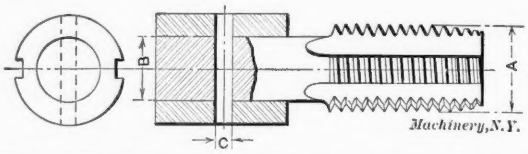


Fig. 1. Safety Arrangement for Saving Taps against Breakage

with two keyways which fit keys in the holder, which do the primary driving. The holder may be fitted with a shank

TABLE GIVING DIAMETERS OF SAFETY PINS FOR TAPS.

Diam. A of tap, inch.	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2
Diam. B of shank, in.	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$
Diam. C of pin, inch.	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$

suitable for the drill press spindle. The taps which go with each holder may have the same outside diameter of

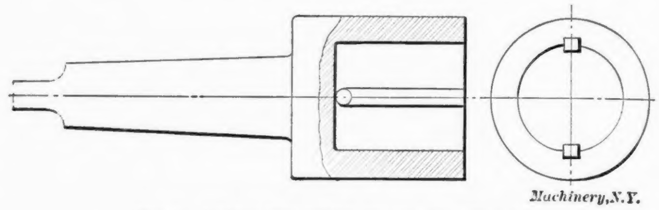


Fig. 2. Holder into which Sleeve over Tap fits

sleeve, but the shank of the tap and the bore of the sleeve, and the diameter of the safety pin will be of the sizes given in the table. HARRY L. RAMBO.

Milwaukee, Wis.

SIZES OF WORKING DRAWINGS

In the March number of MACHINERY, engineering edition, Mr. William Breath in his article on "Sizes of Working Drawings," advocates the use of small drawings for detailing. His plan may be all right, but I think that he carries it too far. For instance, in his illustration of the drawings for a cast-iron bed, he puts the outline drawing on one sheet and the various section drawings on separate sheets. If there are two sections to be shown, this makes three sheets for showing the detail of one casting. Now this particular detail drawing could have been put on one sheet and the following advantages obtained: The man machining this casting would have the whole thing before him all on one sheet, from which he could more clearly see into the construction of the piece; he would not lose one of the sheets, since he has only one; the draftsman would not have to tack down but one sheet; he would not have to repeat some of the dimensions; the work could be done faster, as some of the lines could be projected from the outline view to obtain the cross-section view; there would be only one title and one number to put on the drawing and one record to make in the number book or card index; the checker's work would also be facilitated; the man who approves the drawings would only have to write his initials once; and the blue-print boys would have less work. I agree with Mr. Breath that it is much easier on the draftsman to work on small drawings, but I am in favor of using medium-size sheets for such work as has just been described, and a small scale where dimensions are not too numerous.

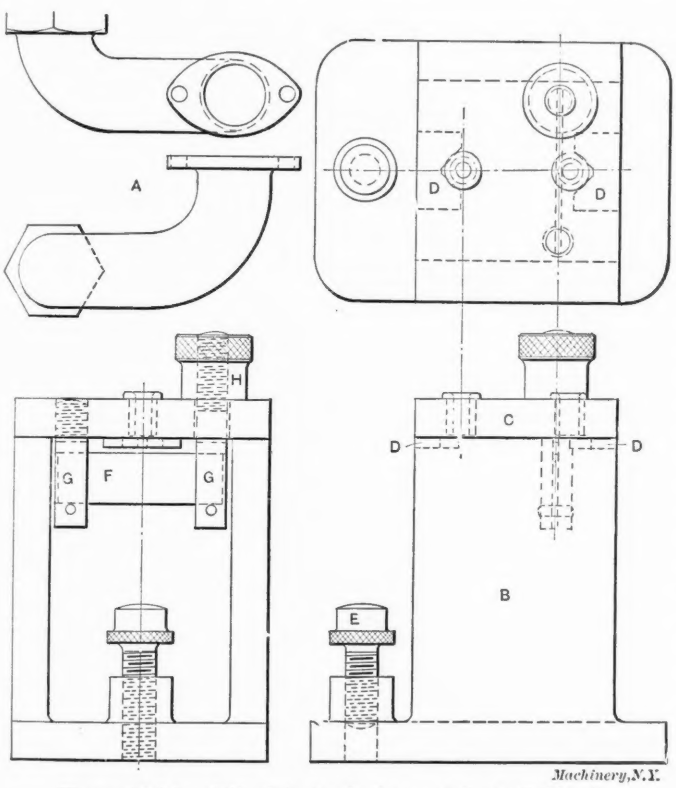
In the drawing room in which I am employed we have four standard drawing sizes. The largest is 21 × 33 inches, the next 16½ × 21 inches, or just half the large size, and the smallest 8¼ × 10½ inches. We generally use the large size for assembly drawings and the next size for details. The sizes are designated by letters, which always follow the drawing number. If there is more than one sheet the numbers are put on the drawings in the following manner: No. 536-A-Sheet 1; No. 537-B-Sheet 2; etc. We use no tracing cloth, but instead the best grade of bond paper; it blue-prints well and does not turn yellow from age. This paper does have a tendency to curl and after being rolled up it is difficult to straighten it out, but this difficulty is overcome by filing the drawings away in large envelopes made from heavy wrapping paper.

By doing this we can file a great many drawings in one drawer; they are easily gotten out, and the drawings are well kept. We mark each envelope on the outside for 100 numbers; for example, one envelope will be marked from 500 to 600. Suppose drawing number 267 were wanted from the file; it would be found in the envelope marked from 200 to 300. The beauty of this scheme is in putting the drawing back in place. Those who have had to file drawings under a big stack of other drawings know how hard it is to get them in place without turning the corners down or disarranging the other drawings. When a new drawing is completed, its number is entered in a book with the subject, the initials of the draftsman and the date. Then cards are made out for the card index, which are filed alphabetically. When the foreman of the machine shop puts several men onto the same job he gets a blue-print for each man and marks with a red pencil the details each man is to make up. J. E. WASHBURN.

Cleveland, O.

SPECIAL JIG FOR DRILLING ELL FLANGE

In a factory which manufactures one of the popular makes of automobiles, it was desired to produce more of the pump outlet elbows shown at *A* in the accompanying engraving. Therefore, to facilitate the drilling, a jig was designed as shown in the three views, which, after a thorough test, proved practical and did accurate work. The ell casting, which was of brass, had but one finished surface, which was that of the flange to be drilled. The two bolt holes had to be at right angles with this surface and the holes in all the elbows had to be drilled alike, in order to make the parts interchangeable. The body *B* and the cap *C* of the jig are held together by



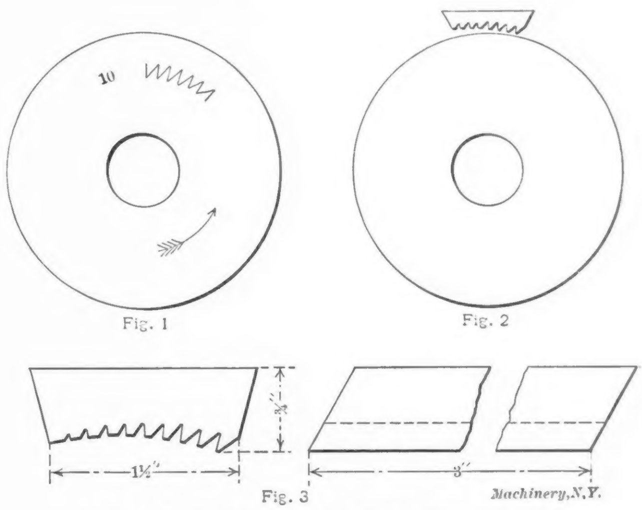
Elbow which has Little Gripping Surface, and Jig for Drilling it

fillister-head screws. There are two steel V-blocks *D*, located so as to receive the flange of the casting. A thin bar of steel *F*, held by pins through the split ends of the studs *G*, clamps the work in place. The thickness of this clamp is only 1/8 inch, as there is not room for one of greater width. One of the studs *G* is stationary, while the other is drawn upward by a knurled nut *H*. When a casting is to be clamped in the jig, one end of the flange is inserted over the bar *F*. The nut *H* is then tightened, and, at the same time, the screw *E*, upon which the casting rests, is also adjusted to the proper height, in order to bring the finished face of the flange against the plate *C*. In this way the casting is clamped square and firm in the jig with little loss of time. Usually when the nut *H* is loosened in order to remove the work, this may be accomplished without changing the adjustment of the screw *E*, owing to the uniformity in the castings and the thinness of the V-blocks *D*. JIG AND TOOL DESIGNER.

GROOVING CHILLED FLOUR MILL ROLLS

The following matter is submitted in answer to the inquiry of K. A. T. concerning the grooving of chilled cast iron flour mill rolls, published in the "How and Why" column of the March, 1909, issue of MACHINERY.

When the rolls arrive at the shop for grooving, they should be unpacked and correctly marked as to the number of grooves per inch, and the direction in which the teeth are



Figs. 1 to 3. Tools for Grooving Chilled Flour Mill Rolls

to lean. (See Fig. 1.) It is essential that the rolls be marked when taken out of the boxes as the box is often marked with the words, "fast roll" or "slow roll," "1st break," "2nd break," etc. This marking avoids confusion since it would be impossible to identify the rolls. The marks are stamped on the ends of the journals, or proper tags attached. The journals are inspected for truth and smoothness. If they are scored, the roll is put into a lathe and the journals turned, previous to grinding.

The grinding machine consists of a bed with two V-grooves to receive and guide the carriage or wheel slide. On one end of this bed is mounted a driving mechanism for operating the carriage and roll, being connected to the roll with a universal coupling. The carriage is actuated by a lead-screw within the bed, and the traverse of the carriage is reversed by a shipper rod on one side of the bed. On the carriage are mounted two emery wheels each on its slide, on opposite sides of the roll to be ground. One wheel may be very coarse and rather hard for roughing down the old corrugations, and one wheel must be soft to produce a good finish. The roll is placed in two V-bearings between the grinding wheels, which bearings are adjusted to allow very little end play of the roll. The roll may now be ground true and parallel, using a copious stream of water. The emery wheels are driven by belts from an overhead drum.

After grinding, the roll is put into a roll-grooving or corrugating machine. It is assumed that the roll is properly chamfered to prevent breaking out at the ends. The roll is held in the corrugating machine between centers, and it also rests on V-bearings, which are placed near the roll proper. It is of paramount importance to have the work rigidly supported.

The machine platen has a head-stock mounted on one end, which carries the feeding mechanism, and through which the helical motion is transmitted. The spiral attachment is similar to the taper attachment of a lathe, and by intervention of a rack and pinion the motion is imparted to the live spindle of the head-stock. From the foregoing it will be understood that the teeth are helical (or spiral as commonly expressed).

The spacing of the teeth is not by the dividing method, but by the feeding method, as it might be termed. For example, a nine-inch divided roll is to be grooved ten corrugations

per inch. Now we find it requires five teeth of the 150-tooth ratchet wheel to move the nine-inch roll one-tenth inch on its periphery. When the machine is properly adjusted and tool set (Fig. 2) the cut is started by making only slight scratches on the roll for an inch, after which the tool is sunk to full depth, yet not reducing the diameter more than a few thousandths inch. When the roll comes near to the starting point again, a pair of dividers are set in the corrugations to get the proper pitch, then the dividers are set in the corrugations, bridging or spanning the remaining blank portion. If the dividers fit correctly the feed may continue until finished, otherwise the roll must be adjusted to make the teeth match properly.

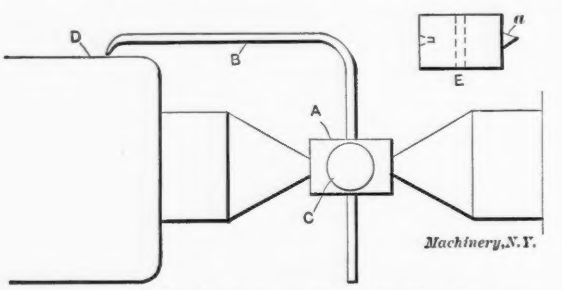
The cutting speed may be anything from twenty-four inches to thirty inches per minute. The steel used for tools should be of a very high carbon steel. The following brands are good: "Crescent Double Special," A1 temper and Firth-Sterling Extra Special," highest temper. High-speed steel is not good because it cannot be made hard enough.

The tool as shown in Fig. 3 will give the best results, since the flat chip is more easily curled than a chip of half round cross-section. The best over-all shape for these tools is that shown in this engraving. M. B. STAUFFER.

Scottdale, Pa.

INDICATOR FOR ALIGNING LATHE CENTERS, ETC.

The indicator shown in the sketch is useful for aligning lathe or milling machine centers, or for setting a center punch mark or jig button central with a boring mill spindle. The gage consists of a short cylindrical piece *A*, accurately centered in each end, through which the adjustable gage wire *B* passes. This wire is held in place by a knurled thumb-screw *C*. When two centers are to be aligned, the gage is placed between them, as shown. The gage wire *B* is adjusted close to the concentric surface *D* and then slowly revolved. When the centers are in alignment, the pointer will follow the surface *D*. If the center of a circle is to be



Indicator for Aligning Lathe or Milling Machine Centers

set in line with the axis of a boring mill spindle, a center in the latter is essential. The cylindrical piece *E* is then used instead of *A*, and the male center *a* is inserted in the center punch mark of the scribed circle. The gage wire *B* is then swung around to come in contact with the surface of the work, which must have been previously set square with the axis of the spindle. When the pointer, as it revolves, follows this surface, the center of the work and the spindle axis are in alignment. To true up a jig button, it will be necessary to have the corner ground to the same angle as the center in the piece *A*, which will have to be enlarged for a button of any size. H. W.

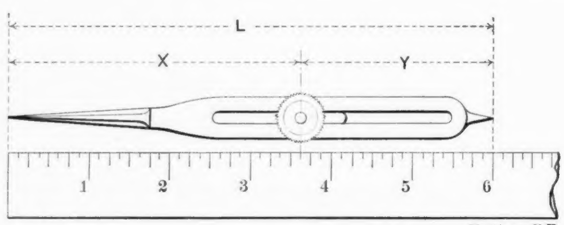
USE OF A LATHE CONSTANT FOR CALCULATING CHANGE GEARS

I wish to suggest a change in MACHINERY'S Data Sheet No. 10 under the head "Change Gears for the Engine Lathe," in the paragraph beginning "Frequently the lathe is designed." Instead of finding out the ratio of the spindle and the stud by counting the number of teeth in the gears of the head-stock, simply look at the index plate and see what thread is cut when the gears on the stud and lead-screw are of equal numbers of teeth. For example, if a screw, three threads to the inch, is cut with equal gears, then call the lead-screw 3 to the inch, notwithstanding what number of threads to the inch it actually has. This we call "the lathe constant." Then if $12\frac{1}{2}$ threads to the inch are to be cut, multiply by any convenient number, 6, for example, and we have $12\frac{1}{2} \times 6 = 75$, and $3 \times 6 = 18$, the numbers of teeth that are required in the lead-screw gear and stud gear, respectively. I have used this rule for many years and have found it very convenient. JAMES EATON.

Burlington, Vt.

TO OBTAIN RATIOS NOT PROVIDED ON PROPORTIONAL DIVIDERS

Users of proportional dividers have, at one time or another, had use for them when a ratio was required other than was provided for by the graduations thereon. To obtain this ratio, I have tried the tightening nut in many different positions before the proper setting was obtained. After doing this recently, for the last time, I concluded that a little calculation would do away with all this trouble. A scale can be used as shown in the illustration, from which to measure



Setting the Nut on the Dividers after the Proper Position has been found by Calculation

to the tightening nut. The position of this nut for any ratio may be found by simple proportion as follows: $R + r : R :: L : X$ or $R + r : r :: L : Y$, where R and r represent the antecedent and the consequent of the ratio; L the total length of the dividers, and X or Y the distance from the ends to the center of the nut. For example, the distance X for a ratio of 0.68 to 0.44 would be obtained thus: $0.68 + 0.44 : 0.68 :: L : X$. C. E. J.

BLUE-PRINT PROTECTOR

The plan of covering blue-prints used in the shop with celluloid, as suggested by Mr. L. H. Georger in the February issue of MACHINERY, and the accompanying editorial note referring to the varnishing method, brought to the writer's mind a method used in the factory of the Coates Watch Tool Co., Springfield, Ill. In the watch-part department of this plant, all the working blue-prints are 5 x 7 inches in size, and are enclosed in strong oak frames, the face being covered with glass. The frames are very similar to cheap picture frames, but heavier, and have a screw-eye at the top to hang them up by, a hook being placed above each machine for this purpose. While this method could not very well be used for large drawings or blue-prints, it is unexcelled for small ones which are in constant use, and the drawings will last indefinitely when protected in this way. E. V.

WOMAN MACHINE SHOP PHOTOGRAPHER

In looking over MACHINERY for April, we notice under the "Personal" notes a statement to the effect that Miss Mimmette Ives Meade is the only woman in the United States who is making a specialty of machine shop photography. We would like to point out that for the past ten years our photograph department has been under the control of Miss Emma G. Moerlins, and we believe that she is the first woman in this country to fill such a position. J. A. MACINTYRE,

West New Brighton, N. Y. C. W. Hunt Co.

LOCATING FINE CRACKS IN STEEL

Fine cracks in tools or other metal surfaces are often difficult to discover as even the microscope frequently fails to disclose them clearly. Their presence and extent, however, are easily detected by moistening the suspected surface with petroleum, and then wiping it clean and covering it with chalk. Some petroleum enters the fissures and afterwards sweats out, moistening the overlying chalk. The cracks can then be readily traced. O. M. B.

HOW AND WHY

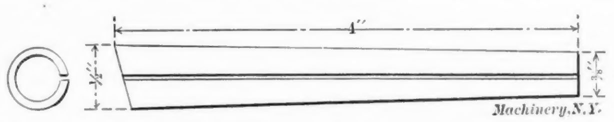
A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

The following questions are referred to the readers:

J. A. J.—How are rolls for rolling silver and gold ground and lapped? What kind of a grinding wheel is used and what diameter and speed are best? At what speed should the work be run? The rolls that I wish to grind are four inches diameter. How much larger should the roll be ground in the center than at the ends to compensate for the deflection caused by the pressure of the stock rolled?

F. W. B.—I would like to ask the readers of MACHINERY for information regarding a reliable and economical method for brazing a large number of conical tubes, which are formed of sheet copper. These tubes are 4 inches long, and have inside



diameters at the ends of ½ inch and ⅜ inch, respectively, as shown by the illustration. The seams where the edges come together must have a butt joint, and must present a neat appearance.

C. K.—I will have a large number of pipe thread dies to recut when they are worn. They are of the inserted or adjustable type 16, 11½ and 8 threads per inch. What is the best and most practical method for doing this work in the average shop? What special appliances are necessary besides the hobs and the holders for the dies.

This question is also submitted to the readers, and an article illustrated with sketches or photographs will be acceptable.

GRINDING BRASS VALVES—TURNING SHAFTING FOR SCREW CUTTING

F. L. Z.—1. What is the proper way to grind and lap brass valves used for steam, water and air, and what material should be used for the operation? 2. What is the best way to turn small shafting, say, four or five feet long, ¾ inch diameter, on which a screw thread two feet long is to be cut?

A.—1. The valves and seats of brass valves for any purpose should be carefully trued on a lathe before grinding. The seats or bearing surface should be made narrow, and very little grinding should be done. Too much grinding tends to destroy the accuracy of the seat, and defeat the object of grinding. Use powdered glass sifted through a cloth bag, mixed with oil. Grind the parts together for a few moments, oscillating the valve and lifting it from the seat slightly so as to prevent scoring and scratching the seat. After a few moments grinding, carefully wipe off the grinding material and note where the bearing is. If all parts appear to be ground alike, put on a little clear oil and grind a few moments longer, and then test the valve, if possible. The watchword in grinding valves is to grind as little as possible. Accuracy must first be obtained by machining operations and the grinding should be limited to just enough to smooth down whatever roughness may be left by the cutting tool. 2. Small shafting of the kind described, should be carefully centered, the centers being drilled and reamed with a combination tool. Turn the shafting in an engine lathe using a back rest to steady the work under the pressure of the cut. Take a roughing and finishing cut, and then cut the thread. The back rest should have two jaws made of brass so as to prevent marring the work.

TO FIND THE DIAMETER OF A CIRCUMSCRIBED CIRCLE

J. F. P.—Three hardened and ground plugs are placed in position as shown by the three inside circles in the accompanying engraving. What is the radius R of the circle which will be tangent to all the three plugs? The only dimensions known are the distances P and C, shown in the illustration.

A.—To solve this problem, we first require the radii of the three plugs. The radius b of each of the two smaller plugs equals one-half of C. The radius a of the larger plug must be calculated. It will be seen that $a = mn - b$, but $mn = \sqrt{mh^2 + hn^2} = \sqrt{P^2 + (\frac{1}{2}C)^2}$. Having thus determined the radius a, we can now proceed to determine the radius R, which is the quantity to be ultimately found in the problem.

Assume that the center of the large circle to be found is at o. The length om, which is not known, we call x. We can now write two equations which can be simplified so as to contain only the two unknown quantities x and R. We first have

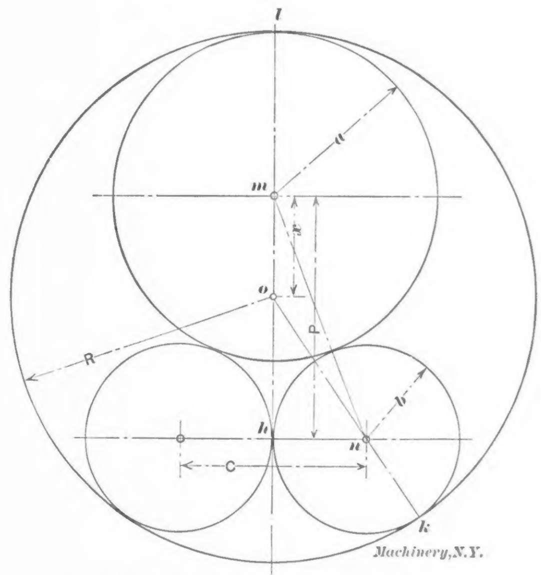
$$R = om + ml = x + a.$$

We also have

$$R = on + nk = \sqrt{oh^2 + hn^2} + nk = \sqrt{(P - x)^2 + b^2} + b.$$

As the members on the right-hand side in both of these equations equal R, they are also equal to each other. Thus we have

$$x + a = \sqrt{(P - x)^2 + b^2} + b.$$



To Find the Diameter of a Circumscribed Circle

If this equation is solved for x, we get,

$$x = \frac{P^2 - a^2 + 2\,ab}{2\,a - 2\,b + 2\,P}$$

and

$$R = a + \frac{P^2 - a^2 + 2\,ab}{2\,a - 2\,b + 2\,P}$$

Assume, for example, that the problem was given with the dimension $P = 1.2$ and $C = 1$ inch. Then $\frac{1}{2}C = b = 0.5$ inch. Radius $a = \sqrt{1.2^2 + 0.5^2} - 0.5 = \sqrt{1.69} - 0.5 = 1.3 - 0.5 = 0.8$.

If we now insert the values of P, a and b in the expression for R above, we have

$$R = 0.8 + \frac{1.2^2 - 0.8^2 + 2 \times 0.8 \times 0.5}{2 \times 0.8 - 2 \times 0.5 + 2 \times 1.2} = 1.333 \text{ inch.}$$

COMPARISON OF FIXED AND VARIABLE SPEEDS

M. S.—Two steamers start from New York at the same time for Liverpool. One steamer makes 18 knots and the other 16 knots. Upon its arrival at Liverpool, each steamer immediately returns to New York; the steamer that made 18 knots continues to make 18 knots on the return trip, but the steamer that made 16 knots makes 20 knots on the return trip. Apparently both steamers should arrive at New York at the same time, as the steamer which makes slow time on the outward trip, makes fast time on the return trip, and the average speed is the same as the speed of the 18-knot steamer. I have seen stated, however, that the 18-knot steamer will arrive at New York first. How can that be explained?

A.—The steamer making 18 knots continuously will arrive at New York first, due to the fact that the average speed of the other steamer which makes 16 knots on the outward trip and 20 knots on the return trip is not 18 knots, as would first appear. The time required on the outward trip by the 16-knot steamer is greater than the time required when returning at 20 knots, so that it is going at 16 knots considerably longer than it is going at a 20-knot speed; consequently the average speed for the time required for the combined outward and return trip is not the arithmetical mean between

16 and 20. Expressed as a formula, the average speed equals:

$$\frac{16\,T + 20\,T_1}{T + T_1} = \text{average speed},$$

in which T = number of hours required for the outward trip,
T_1 = number of hours required for the return trip.

As an example, assume that the total distance from New York to Liverpool is 3,040 knots, then T will equal 190, and T_1, 152, and the average speed would equal:

$$\frac{16 \times 190 + 20 \times 152}{190 + 152} = \frac{6080}{342} = 17.77 \text{ knots.}$$

There is a common application in ordinary shop work of the principle involved in this problem. A planer has a cutting speed of 20 feet per minute, and a return speed of 60 feet per minute. At first thought it may seem that the average speed of the planer platen is 40 feet per minute, but that conclusion is not correct. For simplicity, assume the exaggerated condition in which the stroke of the planer is 60 feet. The cutting speed being 20 feet per minute, the forward stroke will require 3 minutes; and the return speed being 60 feet per minute, the return stroke will require one minute. The total time required for one forward and one return stroke is thus 4 minutes. During this time the platen has traveled two times the stroke, or 120 feet. The average speed thus is 30 feet per minute. The formula for finding this could be expressed:

$$\frac{2\,S}{\dfrac{S}{C} + \dfrac{S}{R}} = \text{average speed per stroke},$$

in which S = length of the stroke in feet,
C = cutting speed in feet per minute,
R = return speed in feet per minute.

This formula can be simplified so as to take the form:

$$\frac{2\,C\,R}{R + C} = \text{average speed per stroke.}$$

If we substitute the quantities of the planer problem above in this formula, we have:

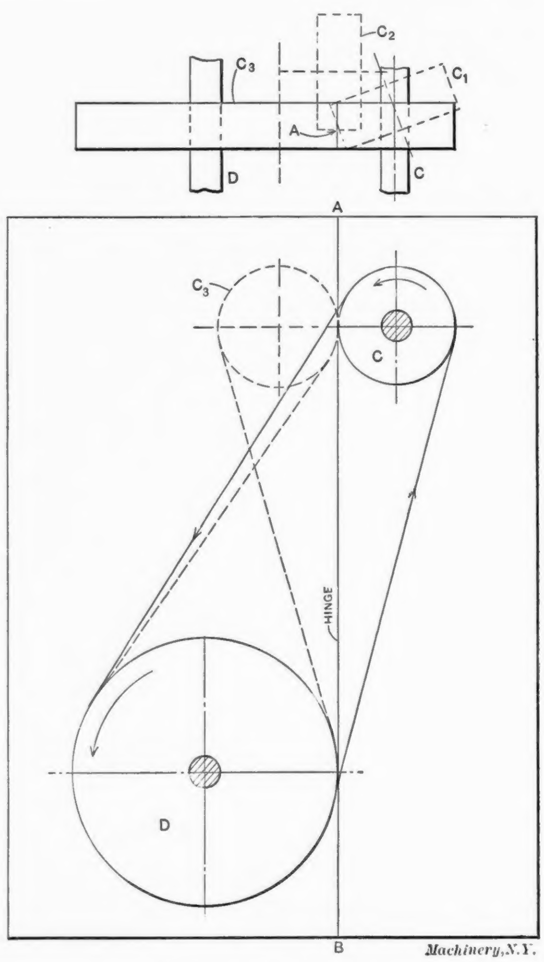
$$\frac{2 \times 20 \times 60}{20 + 60} = \frac{2400}{80} = 30.$$

It should always be borne in mind that the average speed is the arithmetical mean between two given speeds only when the periods of time, during which each speed is in operation, are equal. In this case of forward and return strokes at different speeds, one stroke is made in a shorter time than the other, and the average speed is *not* expressed by the arithmetical mean of the two speeds.

LOCATING ANGLE BELT DRIVES

F. O.—What is the general rule for locating a driving and driven pulley on shafts not parallel?

A.—Reference to the accompanying sketch, which is based on one shown in Spooner's "Machine Design, Construction and Drawing," will make the problem easily understood. First, suppose pulley C to be driven by a straight belt from pulley D on a parallel shaft, and that the vertical line AB is tangent to the middle planes of both pulleys. Now, imagine that the right-hand part of the diagram is bent backward on AB as a hinge. Pulley C and its shaft successively take the positions C_1, C_2, etc., until C_3 is reached, when the shafts of C and D are again parallel, pulley C having been swung through an angle of 180 degrees. In position C_3 the belt would be twisted as indicated by the dotted lines. The belt will run in the twisted position required by C_3 or any intermediate position including the common right-angle position C_2, provided its direction of motion is that shown by the arrows. Hence, the general rule: ***Pulleys connecting horizontal shafts out of parallel must be so placed that a plumb-line dropped from the center of the upper pulley face will touch the center of the lower pulley face; and the retreating part of the belt from each pulley must follow the direction of the tangent (AB) to the pulley faces.*** When the belt is twisted as shown at C_3, the shafts then being parallel, the belt will run in either direction, and, of course a face of the upper pulley need not be directly above a face of the lower pulley. In case it is desired to run an angle drive from a horizontal shaft to a vertical shaft, the same rule can be



Locating Angle Belt Drives

followed as given in the foregoing, except that AB will not be a plumb-line, but will be a horizontal line tangent to the middle planes of a driving and driven pulley face.

LARGE GAS ENGINES

A comprehensive table referring to large gas engines developing over 1,000 horse-power appeared in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*. According to this table 628 gas engines of 1,000 horse-power and larger and representing a total amount of power equal to 1,035,700 horse-power, have been built or are under construction at the present time. Of this total, 412 engines of 613,200 horse-power, or considerably more than one-half of the total, have been built in Germany; 154 engines with 337,500 horse-power in the United States; 33, with 42,200 horse-power in Belgium; 9, with 16,800 horse-power in France; 10, with 13,600 horse-power in Austria; and 11, with 12,400 horse-power in Great Britain. It is rather difficult to explain why the building of large gas engines has made so little progress in so highly developed a country as Great Britain, unless we ascribe this to the traditional conservatism of the Briton. The average size of the engines built in Germany was 1,500 horse-power; in the United States, 2,200; in Belgium, 1,300; in France, 1,900; in Austria, 1,400; and in Great Britain, 1,100 horse-power.

* * *

DATA SHEET CORRECTIONS

We soon shall publish a revised edition of MACHINERY's data sheets, and it is desired that the typographical and other errors in the first edition be corrected. We ask the cooperation of readers using these sheets to help make the new edition free from all mistakes, no matter how trifling. For the best list of corrections and criticisms we will give a prize of $5, and for the second best, $3.

INDUSTRIAL TRAINING THROUGH APPRENTICESHIP SYSTEMS*

The financial statement of every organization summarizes the assets and liabilities of that organization, and details with more or less accuracy the items composing them. Good form forbids the inclusion of any but tangible assets and actual liabilities, yet every organization is dependent for its success on the personnel of its executive and working force, which may be an asset if efficient and aggressive, or a liability if inefficient and decadent.

Efficient organization is the keynote of success. All available sources are exhausted by the modern business manager for material to construct his product, for means for financing his operations, and for energetic men to develop and execute his ideas. We frequently hear that Mr. Blank is a great man; he is identified with a dozen or more corporations; his name alone insures success to those who associate with him. We ask: How can he intelligently direct so many widely diversified industries? Why do his subordinates succeed? The answer is plain: He is a judge of men. He selects the right man for the place, reposes confidence in him, and through him controls an industry as a general through his subordinates controls an army. He recognizes the fact that these men are an asset of his business as much as is the capital invested, and he makes provision to supplement them as necessity demands, just as he provides for a future supply of raw material or sufficient capital to carry out his projects.

He may be able for a time to secure all the men he needs from others who have trained them, just as he may be able to borrow money for the development of his business, but he will have to make both men and money before his success is assured. Every enterprise requires men skilled in the manipulation of its affairs, versed in its various details and operations. The supremacy of an industry, a community, or a nation, is dependent upon the skill and intelligence of its working people.

Prior to the recent business depression, the utmost difficulty was experienced by employers of labor in securing sufficient numbers of skilled workmen. It was no uncommon experience for a concern to hire and discharge five men for every one retained. Really skilled men were not to be had at all in certain lines, and development was arrested on account of the inability to get desirable men. On the other hand, inefficient and unskilled help was plentiful. It is admitted by all that we need more skilled men and that some means must be devised for developing the inefficient and unskilled so that they may be valuable to themselves, their employers, and the community.

The supply of skilled men is not equal to the demand. Our public schools do not educate for any particular trade; our colleges educate broadly but not specifically; our technical schools lay the foundation for engineering professions, but relatively few men have an opportunity to avail themselves of the courses offered. Ninety-five per cent of the children who enter the public schools never reach high-school, and less than twenty-five per cent go above the fifth grade. This means that less than six million out of twenty-four million children in our public schools in 1907 will learn more than is taught in the primary grades. The average child in the United States attends school for less than five years. What does this mean industrially? It means that if we are to have industrially intelligent workers, we must devise means independent of our public school systems for training and developing them.

What Would Apprenticeship Systems do toward Raising our Standard of Industrial Intelligence?

Carefully devised apprenticeship systems operated in the majority of our factories would do much to augment the existing supply of skilled workmen. The need to employers of skilled workmen has already been pointed out; but not only are they necessary as producers—civilization itself has advanced along mechanical lines in such gigantic strides that there is a tremendous demand for, and a serious lack of, skilled men, simply to keep going the wheels of modern life; our towering buildings, our enormous ships, our great bridges—the thousands of mechanisms which are required to transport, to house, to feed, to clothe, to light, to heat, and amuse our people, present an immense field for trained men.

Apprenticeship systems would insure workmen being educated along *definite lines*, thereby meeting the demand for competent leaders. It is of the utmost importance that those who are to occupy executive positions should have familiarized themselves with the various details of the work under their supervision; they should be able to decide whether the judgment of their subordinates is sound, whether the operations required to make some particular piece are correctly performed, whether the quantity and quality of production for which they are responsible is of the required standard. This knowledge can be gained only by actual contact with the work, and a personal study of the conditions under which it is performed.

Apprenticeship systems would offer to young men of limited means, who would otherwise be forced into that large and growing class of unskilled labor, an opportunity to learn a trade. Poverty, disease, and crime are frequently the result of ignorance and environment. Every individual, workman or capitalist, is buoyed up, spurred on, by hope. Picture to yourselves the unskilled workman, earning the minimum wage on which a man can live and support his family. His greatest anxiety is concerning steady employment for himself, his one hope, an opportunity for his children. Where is this opportunity to be found? Not in an education which yields no immediate return, for he cannot support them during that period. His sons must find work, and that as soon as the law will permit, and it must be work which will support them from the beginning, for the father cannot. This means that these boys must take situations which require little, if any, skill; situations which pay practically as much at the beginning as at the end; unskilled work, unskilled wages, with no chance of advancement in either skill or remuneration. So they go on through all their lives, bequeathing to their sons what their fathers bequeathed to them—ignorance and poverty, possibly disease and a tendency for crime. What have they to hope for, to buoy them up, to spur them on? Give boys of this class an opportunity to learn a trade, to be skilled workmen and in demand, rather than unskilled and not in demand, and you solve a large problem in American economics. Apprenticeship systems offer this opportunity.

Do apprenticeship systems pay the employer? Most emphatically *yes*. Many successful concerns who have had apprenticeship systems in operation for a period of years are unanimous in their statements that apprenticeship systems do pay. If properly instructed and intelligently directed, the employment of apprentices is more profitable than the employment of the so-called skilled workman who has been available in the past. Apprentices pay as producers during their term of service; as skilled journeymen when they have completed their course; and as intelligent foremen and executives later on. Those boys who leave at the termination of their apprenticeship become staunch supporters of the mother-shop; always ready to say a good word for it; as loyal as college graduates to their *Alma Mater;* an unequalled advertising medium.

Does it pay the employe to serve an apprenticeship? I firmly believe that it does. He is raised from the ranks of unskilled labor and given an earning power which he could not otherwise command. He is taught to work intelligently and to apply his mind to his work, thus increasing his opportunity for further development and advancement.

What Provisions should Apprenticeship Systems Make for the Employed?

Apprenticeship systems should provide for a proper term of service to insure ample time for thorough instruction. A distinct proportion should exist between the period of time required to learn a trade, and the degree of skill required in the trade. Apprenticeship systems should provide for sufficient remuneration to support the apprentice during his term of service. Applicants for apprenticeship courses will, in the majority of cases, come from the working classes—from the farms in many instances; and they must of necessity have an opportunity for self-support during their period of apprenticeship.

Apprenticeship systems should provide instruction in the technique of the trade and allied studies. The average boy

* Paper read by E. P. Bullard, Jr., before the National Metal Trades Association Convention in New York, April 15, 1909.

begins to learn his trade between the ages of 14 and 17 years. He has not advanced beyond the fifth grammar grade, and probably could not pass an examination on any subject which he has studied. He has not been taught to reason or apply such knowledge as he has. If he is to become a skilled mechanic, it is essential that he should be well grounded in the elementary studies which are allied to his trade. He should be taught the mathematics of his work, the technical terms usually employed, and sufficient reading, writing, and spelling, to supply the deficiencies of his common school education.

Apprenticeship systems should provide instructions in the manipulation and care of the appliances of the trade. I believe there are many who either own or are responsible for valuable manufacturing equipment which is practically at the mercy of unskilled employes or uninstructed apprentices. The average employer would deny this statement, believing as he does that the foreman supervises and instructs his workmen and apprentices. As a matter of fact, the foreman seldom has time to explain to each man or boy such items as the necessity and economy of sufficient lubrication, the function of each mechanism, and the means which should be employed to obtain the most economical results. Being occupied with what are to him more important matters, he is content to let the boy find out these things for himself—an expensive and inefficient system. Every large plant maintains a repair department at a cost which is no inconsiderable portion of its operating expense. Instruction in the care and manipulation of the appliances which it uses would do much to reduce this item.

Apprenticeship systems should provide for the fostering of a spirit of ambition and desire for increased knowledge. Let the apprentice see that his diligence will be rewarded, that he may in time be foreman, superintendent, or manager, if he applies himself to his work, and no difficulty will be experienced in securing all the boys required. If there is anything in a boy this will bring it out; if not, get one who will appreciate his opportunities.

As the employes of any industry may be divided into two classes, producers and non-producers, workers and executers, and as there is need for trained men in each of these classes, I recommend that apprentice courses be arranged to meet these conditions. Let the boy who is bright and ambitious, and who otherwise shows the necessary qualifications, become more than a mere workman, have an opportunity to learn the full trade, including instruction in the studies allied to the trade. Impress upon him the fact that he is given an exceptional opportunity, and demand in return exceptional interest and effort. Advance these boys systematically through the course and weed out such as are not up to a high standing. Select your executives as far as possible from among their number, and thus show them that their efforts will be rewarded.

As the workers outnumber those having executive ability, it is fully as important that as much attention be paid to the development of the former as the latter. Relatively few applicants for apprentice courses have any expectations of ever becoming more than skilled specialists. Why then waste time and money in teaching the full trade to a boy who has neither the intelligence nor ambition to become more than a mere specialist? Provide special courses for these boys covering the various branches of the trade; make the time of service relatively short and wages high as compared to the full apprentice course; give graduates of these special courses an opportunity to learn the full trade later on if they show special ability, allowing credit for the time already served on the special course. The full apprentice course would train boys to fill executive positions. The special courses would develop skilled workmen with a minimum expenditure of time and money.

What is the attitude of labor unions toward the apprentice system? No labor union having the welfare of the workingman at heart can be opposed to well-organized and well-conducted apprentice courses. They may as well be opposed to our public school system on the ground that education is dangerous. The labor union which sets its seal of disapproval upon well-organized and well-conducted apprentice courses admits its ignorance of industrial and social developments and requirements. It cannot have the welfare of its members or the working classes at heart. It should be recognized as hostile to the best interests of employer and employe alike and should not be tolerated in any community. Labor unions can in no way more conclusively show their interest in the welfare of the workingman than by endorsing and furthering the adoption of apprenticeship systems and schools. The apprentice school is a necessary adjunct to any well-organized apprentice system. Few concerns are large enough to support a school of their own as is done at Lynn and Schenectady, and not every community is prepared to establish a technical school such as Wynona or Cincinnati University. Fortunately, however, like industries usually locate in the same neighborhood, so that it is possible for manufacturers employing a similar class of labor to cooperate in the establishment and maintenance of apprenticeship schools.

In Bridgeport, Conn., this has been done very successfully. The members of the local manufacturers' association, working in conjunction with the Y. M. C. A., have established a school for apprentices, who attend two hours per day five days a week. The boys are paid regular wages for the time they spend in the class-room, and the expense for the instructor, who is especially employed for this purpose, is borne by the manufacturers who have boys in the school. The Y. M. C. A. was selected, as the building was provided with class-rooms and had all facilities for carrying on the work. The courses are laid out by a committee of manufacturers, and the work is directly under their supervision. The expenses are nominal and the results secured thus far are satisfactory.

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SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The American Society of Mechanical Engineers will hold its Spring meeting in Washington, D. C., May 4-7. Professional sessions will be held at which papers on the conveying of materials, gas power engineering, steam turbines, the specific volume of saturated steam, oil well pumping and various other subjects will be discussed.

At the reception, which will be held in the New Willard Hotel, an address of welcome will be made by the Hon. B. F. Macfarland, President of the Board of District Commissioners, with a response by Mr. Jesse M. Smith, President of the Society. During the convention President Taft will hold a reception for the members at the White House. The War Department will give a special exhibition drill of the U. S. troops at Fort Myer, to which the members and guests will be invited. At the same time, if the conditions are favorable, an ascension of a dirigible balloon will be made and probably also that of an aeroplane. An address will be given by Rear-Admiral Melville, retired, Past President of the Society, and former Engineer-in-Chief of the Navy, the subject being "The Engineer in the Navy." This evening will be made the occasion for the presentation to the National Gallery of a portrait of Rear-Admiral Melville presented by friends and admirers. It will be received for the National Gallery by Dr. C. D. Walcott, Secretary of the Smithsonian Institution. F. H. Newell, Director of the Reclamation Service, will deliver an illustrated address on "Home Making in the Arid Regions." Trips will be made to various points of interest about the city and a number of pleasurable excursions have been planned. The papers to be presented are as follows: "A Unique Belt Conveyor," Ellis C. Soper; "Automatic Feeders for Handling Material in Bulk," C. Kemble Baldwin; "A New Transmission Dynamometer," Prof. Wm. H. Kenerson; "Polishing Metals for Examination with the Microscope," A. Kingsbury; "Marine Producer Gas Power," C. L. Straub; "Operating System for a Small Producer Gas Power Plant," C. W. Obert; "A Method of Improving the Efficiency of Gas Engines," T. E. Butterfield; "Offsetting Cylinders in Single-Acting Engines," Prof. T. M. Phetteplace; "Small Steam Turbines," Geo. A. Orrok; "Oil Well Tests," Edmund M. Ivens; Safety Valve Discussion; "Specific Volume of Saturated Steam," Prof. C. H. Peabody; "Some Properties of Steam," Prof. R. C. H. Heck; "A New Departure in Flexible Staybolts," H. V. Wille.

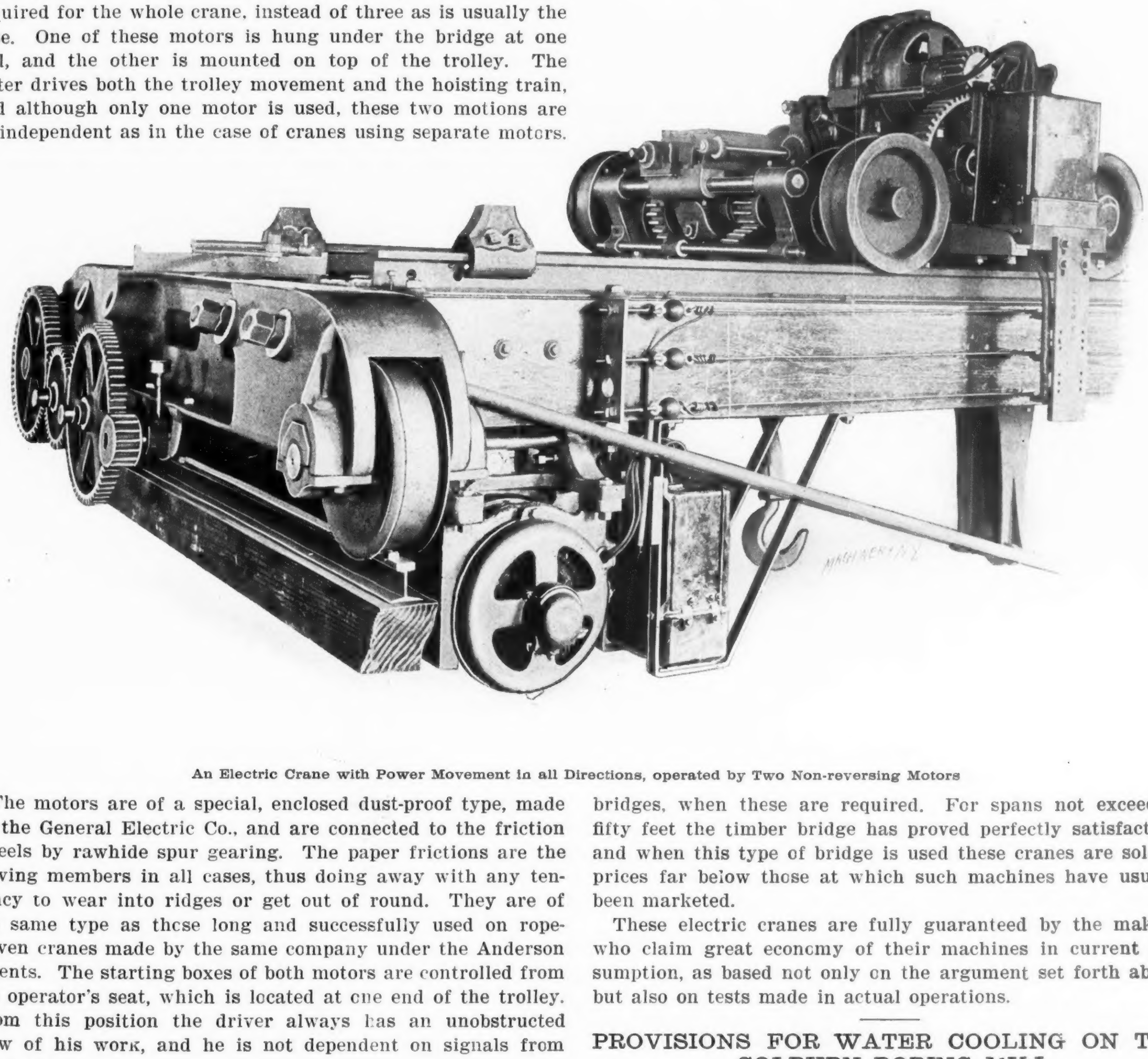
NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

NEW ELECTRIC TRAVELING CRANE

The electric traveling crane illustrated herewith is built by the Lane Mfg. Co., Montpelier, Vt. It is a radical departure in design from usual types, particularly in its use of non-reversing motors. In the conventional electric crane the motors must be stopped, reversed and again brought up to speed for each and every change of movement. As the armatures are heavy and run at high speeds, this means a large consumption of energy in doing useless work.

In the crane here shown, this waste is avoided, and the motor armatures serve as flywheels of considerable capacity in compensating and equalizing the varying demands for current, especially when loads are applied suddenly. The reverse motions are effected by means of bevel paper-and-iron friction wheels, and these are so combined that only two motors are required for the whole crane, instead of three as is usually the case. One of these motors is hung under the bridge at one end, and the other is mounted on top of the trolley. The latter drives both the trolley movement and the hoisting train, and although only one motor is used, these two motions are as independent as in the case of cranes using separate motors.



An Electric Crane with Power Movement in all Directions, operated by Two Non-reversing Motors

The motors are of a special, enclosed dust-proof type, made by the General Electric Co., and are connected to the friction wheels by rawhide spur gearing. The paper frictions are the driving members in all cases, thus doing away with any tendency to wear into ridges or get out of round. They are of the same type as those long and successfully used on rope-driven cranes made by the same company under the Anderson patents. The starting boxes of both motors are controlled from the operator's seat, which is located at one end of the trolley. From this position the driver always has an unobstructed view of his work, and he is not dependent on signals from those below.

The hoisting train is driven by a worm and worm gear running in an enclosed chamber filled with heavy grease and flake graphite, and provided with stuffing boxes to prevent the lubricant working out in hot weather. Owing to this form of drive, a brake is almost unnecessary, but one is provided to prevent racing of the worm in lowering heavy loads. In addition to the customary oiling arrangements, grease cups are provided at all important points, and most careful provision made to prevent the dripping of oil or grease from any part of the crane.

With the exception of the hoisting rope and hook, all parts of this crane are designed with a factor of safety of five. These two elements are purposely made weaker to insure the more expensive and important portions of the machine against serious overloading, as well as to insure that such overloading would be indicated by a gradual failure of the rope or hook rather than by the sudden yielding of some more rigid member. As evidence that only good material and workmanship enter into their construction, the makers state that these machines have on several occasions lifted and carried overloads of more than 2½ times their rated capacity; and while they do not advise such practices, or guarantee the machine for more than its rated capacity, they state that this was done without apparent effort or injury to any portion of the mechanism.

So far these cranes have only been made with bridges of Southern pine, trussed with wrought-iron rods, but the makers expect to be able to offer them at an early date with steel bridges, when these are required. For spans not exceeding fifty feet the timber bridge has proved perfectly satisfactory, and when this type of bridge is used these cranes are sold at prices far below those at which such machines have usually been marketed.

These electric cranes are fully guaranteed by the makers, who claim great economy of their machines in current consumption, as based not only on the argument set forth above, but also on tests made in actual operations.

PROVISIONS FOR WATER COOLING ON THE COLBURN BORING MILL

In the January issue of MACHINERY we printed a little story, at least 95 per cent true, entitled "The Adventures of a Water-Cooled Boring Mill." In this story was described the evolution of an effective guard to retain water or other lubricant used for cooling the tool and the work, when using high-speed steels in the boring mill. The Colburn Machine Tool Co., of Franklin, Pa., has sent us a description and photographs, herewith reproduced, of an arrangement of the same kind as that we described, which it has applied to one of its latest 34-inch boring mills.

The essential features in a guard of this kind are: First, it must thoroughly protect the operator and catch all the lubri-

cant; it must thus extend above the highest and below the lowest part of the revolving chuck or table. Second, it must be so designed that it will not be in the way of the wrench in the clamping or unclamping of the chuck, and it must not interfere with the placing or removing of the work. These conditions are fully met in the device shown in Figs. 1 and 2.

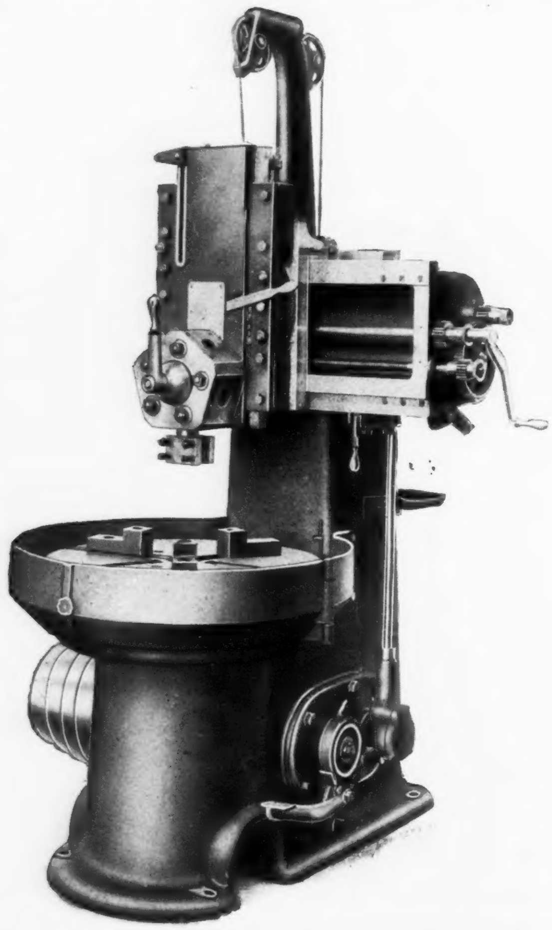


Fig. 1. The Colburn Boring Mill, as arranged for Water Cooling

As may be seen in Fig. 2, the guard consists of four pieces. Two supporting brackets are bolted to the frame of the machine, one on each side. These brackets form part of the guard and are of the same shape as the front part. The stationary brackets encircle one-half of the entire table or chuck, and at their outer ends have hinges to which are attached the front sections of the guard. These two front sections, or wings, may be opened and swung backward as shown in the

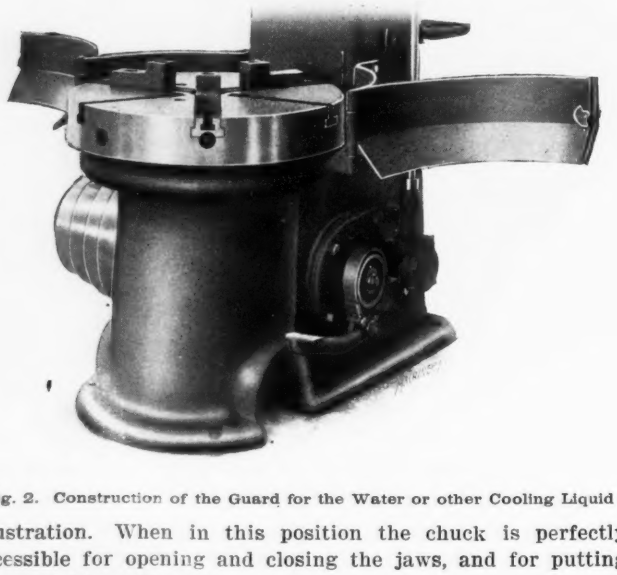


Fig. 2. Construction of the Guard for the Water or other Cooling Liquid

illustration. When in this position the chuck is perfectly accessible for opening and closing the jaws, and for putting on and taking off work.

When closed, as shown in Fig. 1, the two wings are locked together by means of a latch operated by the handle or knob in front. A suitable trough made of sheet metal can be attached underneath the guard to drain off the lubricant and catch the chips, or the chips and lubricant can be allowed to fall to the floor into a large pan under the entire base of the machine. By using a large pan of this kind, all the lubricant and chips falling from the guard, as well as through the hollow spindle, can be caught, and by means of a suitable pump the lubricant can be carried back to the work again.

This provision greatly increases the capacity of the boring mill on certain classes of work, such as the machining of steel and aluminum, where it is very advantageous to use oil, water, kerosene or other lubricant adapted to the particular material in hand. This is regular practice in certain kinds of lathe and screw machine work, and suitable means for taking care of the liquid are regularly provided. The same advantage results from their use on the boring mill, though it is not so easy to make effective guards. This arrangement, however, appears to serve its purpose well, and should thus be of material advantage in increasing the output of the machine.

NEWARK GEAR-CUTTER GRINDING MACHINE

The illustration presented herewith shows a form of cutter grinding machine especially adapted to the sharpening of gear cutters, which has recently been devised by the Newark Gear

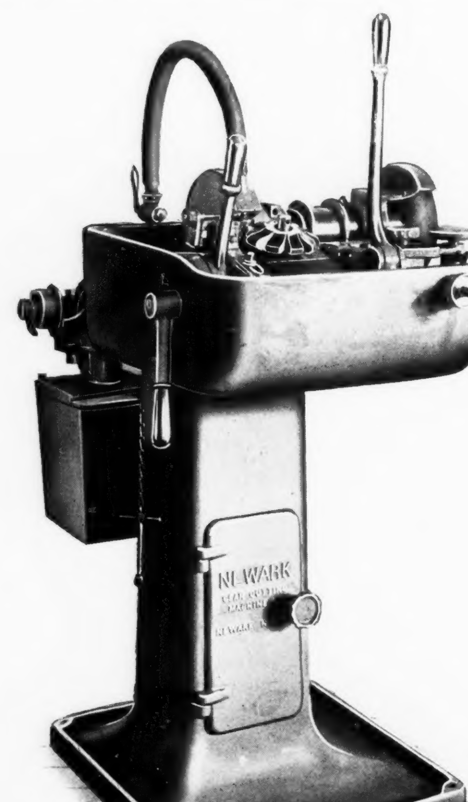


Fig. 1. Special Water-cooled Grinder for Sharpening Formed Gear Cutters

Cutting Machine Co., 66 Union St., Newark, N. J. The cardinal points aimed at in the design are a combination of simplicity and accuracy in operation, and the supplying of a machine which is always set up for grinding gear cutters, without the use of special, loose attachments as required by universal grinding machines.

The cutter to be ground, *A* in Fig. 2, is mounted on a fixed stud to which it is fitted by bushings which are part of the equipment. The table in which the stud is fixed is adjustable parallel to the axis of the grinding wheel spindle, so as to set the edge of the wheel in line with the center of the cutter stud *A*. The stand *B*, upon which the table is mounted, is adjustable upon a horizontal trunnion *C*, thus providing means for tilting the table up and down. This allows coarse-pitch gear cutters, as shown in Fig. 2, to be ground in two corners

between the teeth, without changing the wheel or removing the cutter from the stud. It also affords a quick adjustment for placing the cutter central with the wheel to suit the different thicknesses of cutters used. This tilting adjustment is controlled by the upright handle at the left of the machine, and is locked by the handle hanging down on the outside of the pan at the left. The feeding of the wheel in toward the cutter is effected by the vertical handle at the right. A stop screw is provided for this movement.

There is a pawl on the cutter table which is adjusted to touch the back of the tooth to be ground. After being once set, the

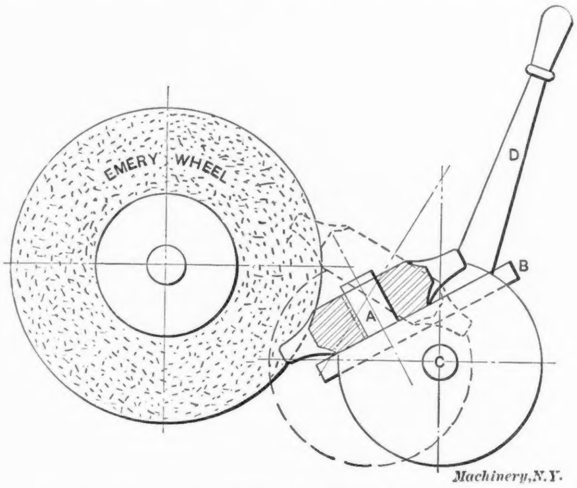


Fig. 2. Adjustment of Table, permitting Grinding the Sides of Large Cutters

cutter can be rotated from tooth to tooth past the pawl. After cutting once around, an adjusting screw shifts the pawl so as to rotate the cutter slightly, giving a little deeper cut. This adjustment, which constitutes the feed, always results in a radial tooth after the wheel is once set in line with the center of the stud. No dials are used for indexing, as the pawl operates on the backs of the teeth of the cutter itself. For this reason it is not necessary to count the number of teeth in the cutter, or to select suitable dials for that number. This makes the action of the machine very rapid, the makers claiming that it is possible to grind the cutter while the indexing mechanism of other machines is being set. Its simplicity also gives it the advantage of being less subject to the wear which is bound to occur in a grinding machine of any kind.

As may be seen, this machine is arranged for water cooling. The liquid is supplied by a centrifugal pump supported at the rear of the column. Baffle plates are provided for separating the grinding dust from the water. The large pan is a splash basin merely; the water does not remain in it but flows into a reservoir. Among the other conveniences furnished with the machines is the provision of fixed handles, largely avoiding the use of wrenches, and facilitating the use of the machines. Where wrenches are required, they are fastened to the base of the machine by chains, as shown, to prevent them from being lost or taken away for other machines. This arrangement was found advisable in the shop of the builders, as it is a great advantage to have this machine always ready for instant use. The column is of box form and contains a cabinet for cutters, grinding wheels, etc.

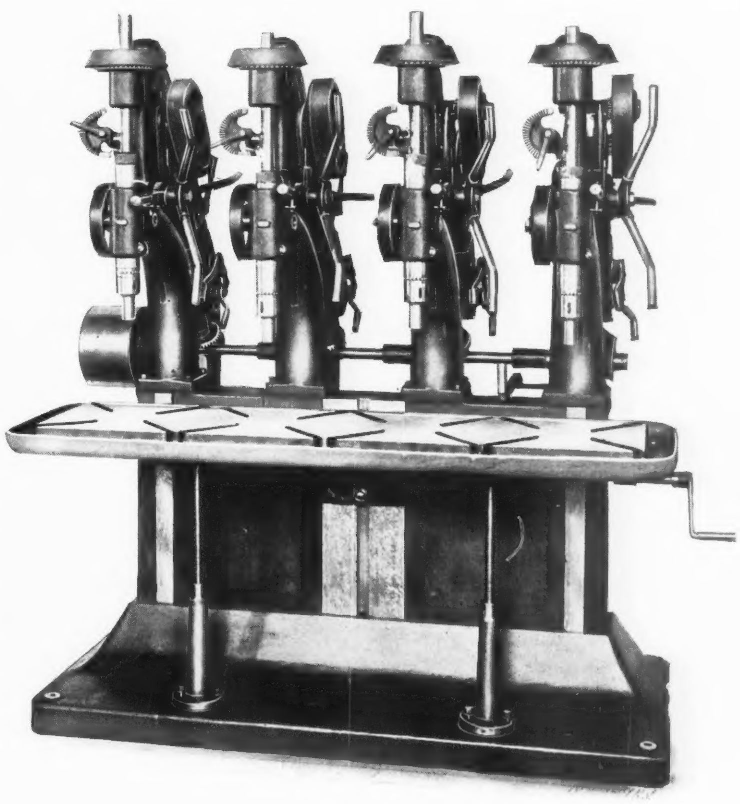
The machine will take cutters from 1¾ up to 8 inches in diameter. The grinding wheel is 8 inches in diameter with a 1-inch hole, and is of dished form. It is mounted on a hardened and ground spindle running in bearings of phosphor bronze adjustable for wear. The end of the spindle at the right, outside of the water basin, is used as a hand tool grinder, and will use up wheels after they are worn too small for the gear-cutter grinder. A hand rest is provided for this end of the spindle. The regular equipment includes two grinding wheels, the diamond truing device, and bushings which, in connection with a ⅞-inch stud, will take cutters having ⅞-, 1-, 1 1/16-, 1½-, 1¾- and 2-inch holes. An overhead countershaft is also furnished.

BARNES DRILL CO.'S GEAR-DRIVEN GANG DRILL

The geared drive drill press made by the Barnes Drill Co., 602 S. Main St., Rockford, Ill., was described in the New Tools department of the May, 1908, issue. On this drill press a gear box giving four changes, and a back-geared drive, which doubles this number to eight, are used, eliminating the use of cone pulleys entirely. Positive and quickly obtained feed changes are also provided, ranging from 0.001 to 0.025 inch. Four of these tools have been combined by the makers in the form of the gang drill shown herewith, for use on work requiring several operations.

The four spindles are driven by a single shaft passing from side to side through the machine. Any single spindle may be instantly stopped by throwing the speed-changing lever into the central position, thus throwing the transmission gears out of mesh. All the changes of speeds and feeds are made instantly by the operator from the front of the machine, without stopping the spindle. This holds true with the back gears as well as the regular changes. The feed-changing lever is shown at the left of each spindle, centered on the ratchet-faced segment by means of which it is set. For tapping, any or all of the spindles will be furnished with reversing friction clutches. The spindle at the right of the machine in the engraving is so equipped.

The table is surrounded by an oil channel as shown, and is supported by two screws, thus making it very rigid for heavy pressure on large work. The table is raised and lowered by means of a crank at one end. When desired, this gang drill will be furnished with independent columns for each spindle to sit on a heavy bed base with separate tables, either round



A Four-spindle Gang Drill, with Independent Gear Speed and Feed Changes

or square. Either style of machine can be furnished in two, three, four or six spindles.

General strength and convenience have been carefully looked out for in this machine. Each spindle has the same capacity as the makers' all-geared 20-inch drill—that is to say, it will properly handle 1-inch twist drills in steel without back gears, or 1½-inch drills in steel with back gears. It will drive a tap up to 2 inches in diameter in cast iron. Each head has a

back brace which adds greatly to its strength and stiffness. The driving gearing is unusually large and strong, as is also the spindle, which is double splined. A No. 3 taper is regularly furnished on the spindle, but a No. 4 will be supplied when desired. The drift hole is placed below the sleeve, so that it is unnecessary, when removing the drill, to rotate the spindle to match a hole in the sleeve.

The machine stands 72 inches high in all, and the spindles are spaced 5 inches from center to center. Each of them will drill to the center of a 20-inch circle. The vertical travel of the spindle is 10 inches, and of the table 14 inches, giving a maximum distance from the spindle to the table of 27 inches. The planed surface of the table for the 4-inch spindle machine measures 14 by 60 inches. The four-spindle machine is driven by a pulley 12 inches in diameter and 5 inches wide, running at 400 revolutions per minute.

NAPPANEE PORTABLE BORING BAR

The boring bar illustrated herewith is made by the Nappanee Iron Works, of Nappanee, Ind. It is designed for general boring, though especially adapted to the re-boring of cylinders up to 36 inches in diameter. By the use of this tool the cylinders of all kinds of engines, air compressors, steam hammers, pumps, blowing engines, Corliss valve seats, etc., can be re-bored in place in any position and in cramped quarters if necessary, such as are met with on board ship.

This tool is of the construction which provides for the supporting of the boring bar at one end by bushings in the stuffing-box bore, and at the other by a universal adjustable

A Portable Rig with Automatic Feed, for Re-boring Cylinders of Steam and Gas Engines, etc.

support, fastened usually to the flange of the cylinder. When supported in this way, cylinders can be re-bored in less time than it would take to remove them from their fixed position. All steam connections, studs, anchor bolts, etc., remain intact. Enough cutter heads, arms and tools are furnished with each size of bar to cover the full range. The bar is powerfully geared and can be driven by hand or power. The steel feed-screw is firmly mounted in the bar, giving a strong and rigid movement. The feed nut is made of brass, and is accurately fitted with a square thread, 8-pitch feed-screw.

The features to which the builders desire to call particular attention are the compactness, strength and simplicity of construction. The wide range should also be noted. The No. 3 size will bore from 7 to 36 inches in diameter. The simplicity of construction enables the device to be sold at a low cost. Inquiries addressed to the manufacturers will be referred to the nearest dealer handling these machines.

LATHE GRINDING ATTACHMENT FOR INTERNAL AND EXTERNAL WORK

The accompanying illustrations show an electric grinding attachment for the lathe which may be arranged for either external or internal grinding, provision for the latter operation being made by the use of an internal attachment similar in principle to that applied to regular cylindrical grinding machines. This tool is built by the United States Electrical Tool Co., of Cincinnati, Ohio.

The grinding spindle, and the motor, of which it forms the armature shaft, are adjustable on a horizontal slide, which is, in turn, vertically adjustable on the face of a knee clamped to the swivel of the compound rest of the lathe. This method of supporting gives a feed at any angle by the adjustment of the compound rest base, and the operation of the lead-screw on the horizontal slide attachment. It also permits the centering of the wheel spindle with the center line of the lathe by the vertical adjustment of the motor and slide on the knee.

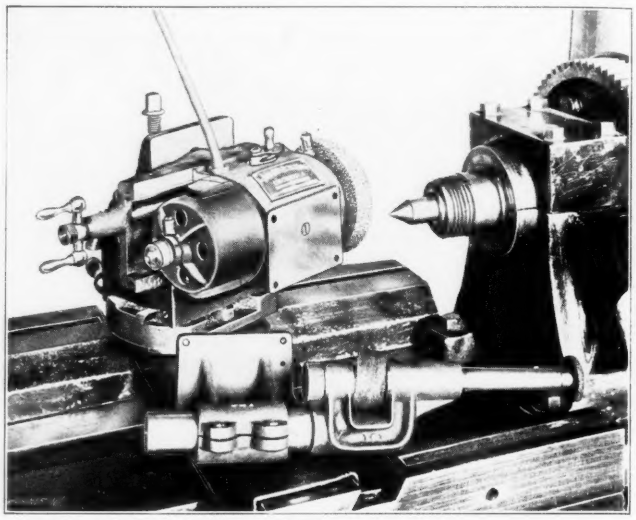


Fig. 1. Electric Grinding Attachment Mounted on Compound Rest Swivel of Lathe

Fig. 1 shows the device as used for external grinding. In this particular case the compound rest has been set at an angle to true up the live center. The wheel is fed back and forth for this operation by the feed-screw of the attachment. When arranged for external grinding, it may also be employed for sharpening reamers and cutters in the lathe, and in finishing mandrels, dies, etc., in a lathe, planer or shaper, it being evidently adaptable to surface grinding as well as to cylindrical grinding.

Fig. 2 shows the internal grinding attachment (which is dismounted in Fig. 1) attached to the face of the motor and in use grinding a hole in a die. Conical, dust-proof bearings, adjustable for wear, are also used in this attachment as well as on the main grinding spindles. The device is belt-driven by means of a large pulley on the armature

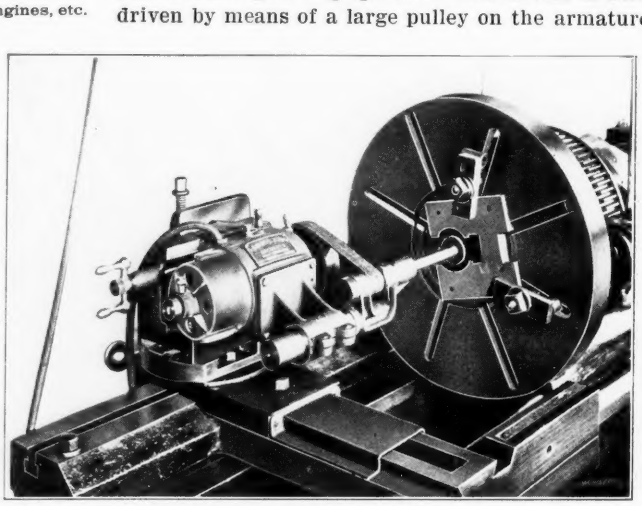


Fig. 2. Internal Grinding Spindle in Use

shaft and a small pulley on the grinding spindle. When a 1¼-inch wheel with a ¼-inch face is used on the latter, it may be speeded up to 18,000 revolutions per minute. When arranged for internal grinding it is adapted to the finishing of dies, gasoline engine cylinders and internal grinding of all kinds.

This grinder can carry emery wheels ranging from 4½ to 12 inches in diameter throughout the range of the four sizes for which it is made. Internal grinding attachments which will grind holes varying in depth from 4½ to 8 inches will be supplied. The motor is wound for 110 or 220 volts direct

current, or for the same voltages on a 60-cycle, one-, two-, or three-phase alternating current circuit.

GRAHAM PRESSED STEEL GRINDER CHUCKS

The Graham Mfg. Co., of Providence, R. I., has placed on the market an all-steel chuck designed for holding ring emery wheels. While intended primarily for use on machines of the disk grinder type, they are adapted also for any other machines in which the side of the wheel is used for the grinding. The main points of interest in this device are the use of a body of pressed steel without any projections to speak of, the provision of an adjustable backing flange for setting the ring out as it wears down, and the provision of a simple and effective clamping device. Care has also been taken to make the design of the centers on which the chuck is mounted such that they will readily fit machines of widely varying construction.

Fig. 1. A Chuck for a Face Grinding Wheel having a Pressed Steel Body

A reproduction of a photograph of the chuck is shown in Fig. 1, while Fig. 2 gives details of its construction. The body *A*, as has been mentioned, is made of pressed steel, turned and finished all over. While very light this has all the strength required for the work it has to do. In this respect, it is much more reliable than cast-iron or steel castings, owing to the small amount of stock which has to be removed and the avoidance of blow holes and other hidden defects.

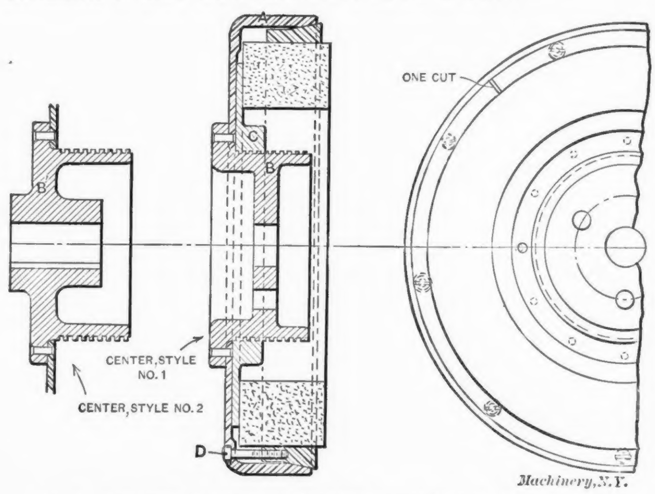


Fig. 2. Sectional View of the Graham Pressed Steel Grinding Chuck

This body is fastened by small rivets to the cast-iron center *B*, which is made to suit any style of spindle. Two examples of varying styles of center are shown, one at *B* and the other at *B'*. The first would be used for disk grinders, and the second for all kinds of face grinding machines, such as used for work on knives, safe plates, guide bars and special work. This center *B*, which is threaded on its periphery, serves also as a screw for the setting-out nut *C*. This nut is turned by a straddle wrench provided with pins to engage holes drilled for the purpose, which show quite plainly in Fig. 1.

The clamping device consists of a split ring drawn into a tapered conical bearing in the body *A*, by numerous screws *D* at the back. This ring has but one cut in it, which has been found by experience to be sufficient. This gives a very powerful and satisfactory grip. Provision is also made, when necessary, for the use of sectional blocks of emery, in place of solid rings, though this is not illustrated in either of the engravings.

Chucks of this kind are called for principally by users of disk grinders, whose work requires something less expensive and more durable than emery cloth. These chucks are known in size by the outer diameter of the grinding ring rather than the over-all dimension. In this particular design this outside diameter has been reduced greatly in comparison to that of the wheel, owing to the use of the pressed steel body. These chucks are made to take rings from 9 inches to 30 inches in diameter, and weighing from 40 to 330 pounds for the different sizes. On the very largest of them the outside diameter of the body is not more than 2 inches larger than the diameter of the ring.

WRIGHT QUICK-ADJUSTING WRENCH

The Wright Wrench Co., of Canton, Ohio, and Tacoma, Wash., has designed the simple and quickly-adjusted wrench shown herewith. Fig. 1 shows the tool in the workman's hand, while Fig. 2 shows its construction. Its simplicity is evident.

It is composed, as may be seen, of two main members—the outer jaw and handle *A*, of one piece, and the sliding jaw *B*. The latter carries in a recess a toothed gripping block *C*, which engages the corresponding teeth of a ratchet strip *D*.

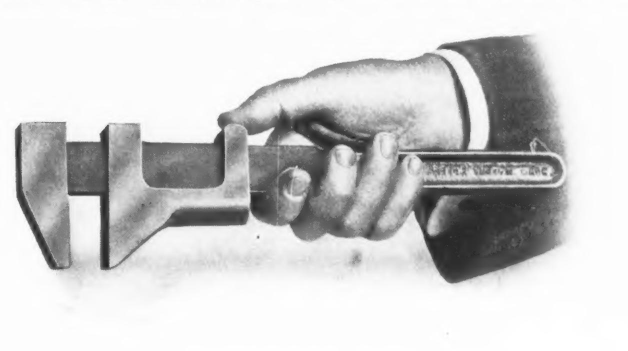


Fig. 1. The Wright Quick-adjusting Wrench

Spring *E* tends to hold the teeth of the block in contact with those of the strip and thus lock the wrench. By pressing down on the outer end of the jaw with the thumb, however, as shown in Fig. 1, these teeth are disengaged, and the thumb is free to slide the jaw to any adjustment throughout its range. Releasing the hand of the operator again sets the adjustment in the new position.

The handle and outer jaw are made of 20-point carbon, open-hearth, drop-forged steel, carbonized, mottled and hardened. The sliding jaw is made of carbonized semi-steel, also mottled and hardened. The rack and pawl are of carbon tool steel. All these parts are hardened. The spring steel wire is of oil tempered steel. The parts are milled, ground and polished before putting on the mottled finish, which resists rust and is far superior to a bright finish in durability. The carbonizing is done from the makers' special formula.

The American Locomotive Co., recently made a comparative

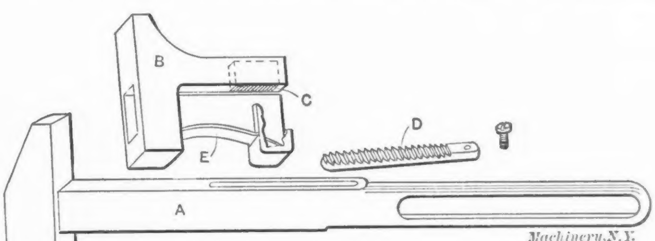


Fig. 2. The Construction of the Wright Wrench

test to destruction of a series of 12-inch wrenches, using many forms and shapes. These failed at a leverage of 7 inches from the center of the nut at pressures varying from 1,700 to 4,000 pounds. All the other wrenches fractured in such ways as to make the jaw useless. The Wright wrench became inoperative at 2,600 pounds, owing to the giving out of the ratchet mechanism. Since this can be repaired at a cost not to exceed 10 cents, it will be seen that the tool is easily made as good as new, and ready for service even at this high pressure.

The tool is made in various sizes from 6 inches up to 18 inches. It will take small hexagon nuts or finished screw

heads and leave them in as good condition as the ordinary screw adjustment wrench, since provision is made to avoid back lash, and the wrench will not lock on the nut or lose its adjustment while in operation.

WALTHAM CLUTCH CUTTING MACHINE

The Waltham Machine Wks., Newton St., Waltham, Mass., makes the automatic clutch cutting machines shown herewith. They are designed for cutting the ratchet-shaped teeth on the clutches used in the stem-wind mechanism of watches, or for cutting teeth of any shape on small parts, in which the direction of the cut is at right angles to the axis of the work. They are made in two styles, shown in Figs. 1 and 2 respectively. In Fig. 1 the machine is arranged to stop after the completion of the last cut so that the work may be removed and a new piece put in by hand. With the machine

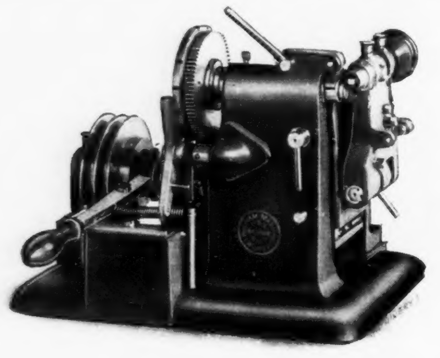


Fig. 1. Automatic Face Clutch Cutting Machine for Small Work

in Fig. 2 the mechanism runs continuously, the blanks being fed from a magazine and removed automatically from the machine.

The blank is held by a spring chuck in an indexing spindle at the front of the machine. The cutter spindle is carried in bearings attached to a swinging arm. These bearings are normally at right angles to the axis of the work spindle but may be swiveled somewhat so that a slight undercut may be made. The swinging arm in turn is carried by a vertical slide operated by a cam. The support for this

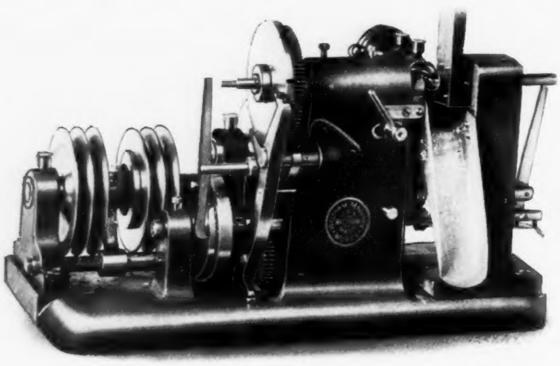


Fig. 2. Clutch Cutting Machine, with Magazine and Automatic Feed

slide can be swiveled 5 degrees to either side of the vertical position, so that angular cuts can be made. Screw adjustments are provided for centering the cutter and setting it to the depth of cut. The adjustment for the location of the cut is made by an eccentric on the swing shaft.

The pitch of the feed cam is made to suit the particular work on which the machine is to be used. The cut is made from the top downwards and the cutter is swung away from the work during the return to allow for indexing. A friction indexing mechanism is used. An important provision in the machine is that for cutting the work around twice for the purpose of removing the burr on the tops of the teeth made by the first cut. This second cut is made at a considerably increased speed.

The machine shown in Fig. 2 is practically identical with that shown in Fig. 1 except for the addition of the mechanism necessary for the automatic handling of the work in placing it in the chuck and removing it after completion. The magazine in which the blanks are placed is shown extending upward at the right. The use of this automatic attachment adds from 20 to 25 per cent to the production of each machine and permits one operator to care for a large number of them. The machine illustrated here will cut teeth of 64-pitch or finer.

NORKA TWO-GROOVED HIGH-SPEED TWIST DRILL AND CHUCK

In the department of New Machinery and Tools in the April, 1908, issue of MACHINERY, we illustrated two designs of high-speed drills, made by the Whitman & Barnes Mfg. Co., of Akron, O., and Chicago, Ill. One of these was a flat drill,

Fig. 1. The Norka High-speed Twisted Drill

and the other a twist drill made of high-speed steel, twisted while hot so that the grain of the steel was not disturbed. This method of making gives these tools great strength and durability in the most refractory materials. The construction has since been improved, as shown in the accompanying illustrations, giving apparently a drill of somewhat simpler form and a more compact chuck.

The drill, it will be seen, has no tang, the driving being done on the whole length of the shank. In twisting the drill,

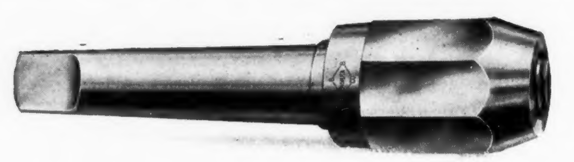


Fig. 2. Special Chuck for Norka Drill

a section of the stock is left untwisted and this part, being grooved, forms the shank. The jaws of the chuck are carefully machined to fit this groove, so that the drill is not only held securely, but centrally as well. The whole drill is ground to size, and may be used for work of the highest accuracy. It is made of "W. & B." high-speed steel, mixed to the manufacturer's special analysis, which gives the drills the necessary hardness to secure the maximum amount of work, and at the same time retains the toughness required to reduce splitting and breakage to a minimum.

The chuck, as stated, is accurately made. The jaws are locked on the drill by a heavy clamping nut. Figs. 2 and 3 show the chuck alone, and with the drill in place, respectively. The

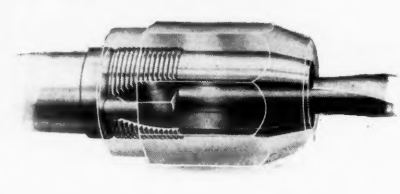


Fig. 3. Drill in Chuck, showing Long Grip in the Grooves

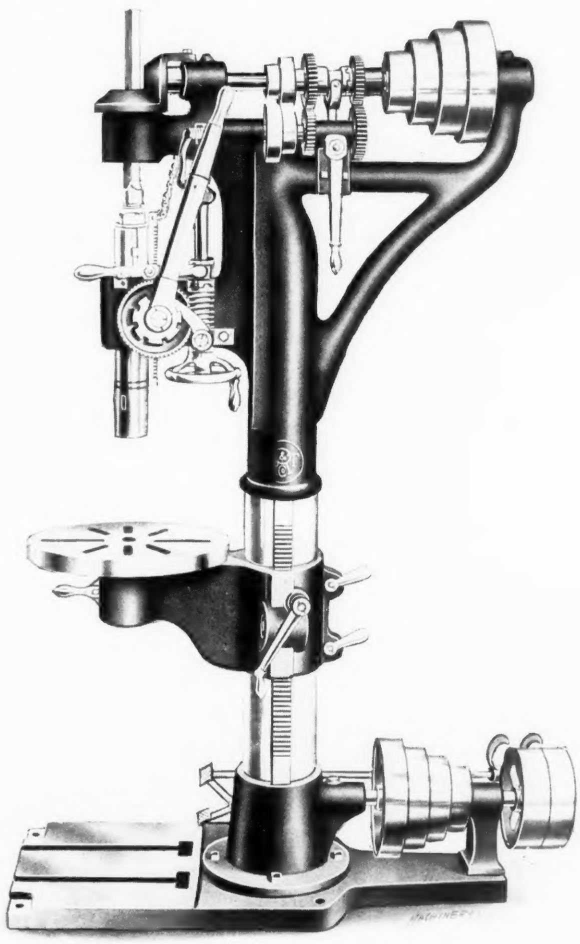
thrust of the drill is taken (it will be seen) by a loose key inserted between the jaws at the bottom of the slot. There are thus but three pieces in this tool.

ROBERTSON 21-INCH UPRIGHT DRILL

The Robertson Drill & Tool Co., 1848 Niagara St., Buffalo, N. Y., is completing the drilling machine illustrated herewith, which combines a number of new features while retaining standard constructions which have proved their value by long use. Special attention is called to the spindle drive and to the back gearing. Instead of keying the spindle to the driving gear as usual, the spindle is made of square section, accurately fitting a corresponding hole in the gear. This obviates all danger of cramping, met with in the older construction. Its efficacy is especially noticeable in tapping. It is common, for instance, in drilling even the heaviest work, to have it raised from the table by the action of the tap, this being made possible by the side thrust or cramping

of the keyed spindle in the gear. With the square spindle drive the same piece requires no clamping, thus showing that less power is required and that friction has been eliminated to a large degree.

The back gears can be thrown in or out, or the spindle stopped, by the back gear handle shown. This can be done while the machine is running at full speed without danger of excessive shock. While the drive in general follows the lines of the standard drill press, this machine has been built throughout from original patterns and designs. No attempt has been made to meet competition by furnishing a tool which is too light and weak for the size of work it is intended to perform. A 5½-inch diameter column is provided with this 21-inch drill, and the diameter of the spindle through the quill is 1 9/16 inch. The table is raised by a crank operated through a self-locking worm gear and pinion. All clamps are provided with attached handles, making the use of wrenches unnecessary.



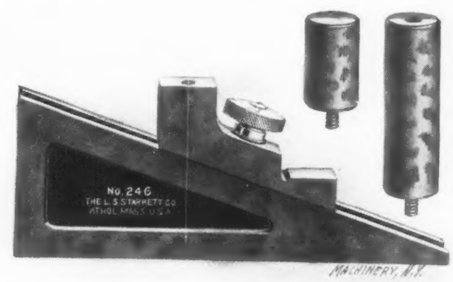
Heavy Duty Drill, with Power Feed and Automatic Stop

The following dimensions will give an idea of the capacity and rigidity of the machine: Diameter of the column, 5½ inches; total height of the machine, 60 inches, and net weight, 650 pounds. The counter-shaft runs 250 revolutions and has tight and loose pulleys 8 inches in diameter for a 2½-inch belt. The largest step of the cone pulley is 9 inches, and the smallest 4½ for the 2½-inch belt. The machine will drill to the center of a 21¼-inch circle. The table is 15¼ inches in diameter, and has a vertical travel of 40 inches. The vertical travel of the spindle is 10 inches; it has a No. 3 Morse taper hole. All parts are well ribbed and of good workmanship. The gears are cut from the solid, the racks and small pinions being cut from steel. The plain wheel and lever are power-fed, and automatic stop and quick return are provided.

STARRETT PLANER AND SHAPER GAGE

The L. S. Starrett Co., of Athol, Mass., has added to its line of machinists' tools, the convenient planer and shaper gage shown herewith. This gage is of the adjustable wedge type; it is made of drop-forged steel and is so constructed as to give a wide range of measurements. It can be set to any dimension from ½ to 5½ inches. As may be seen, gage surfaces of two different heights are provided, and the upper one is arranged to be extended by the use of the screw blocks shown, either or both of which may be used.

It will be found convenient on other work besides planing. It is very useful, for instance, on the miller, where slots are

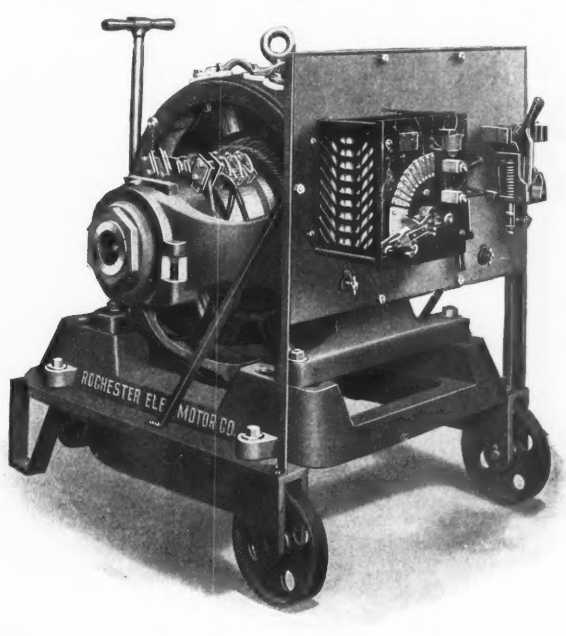


An Adjustable Gage for Setting Planer and Shaper Tools, etc.

to be machined. The gage can be inserted in the slot and the blocks adjusted until a perfect fit is obtained. Then the tool may be removed and the exact measurement taken by the use of a micrometer. Where a close measurement is required, the tool can first be set by the micrometer and then used as a standard gage. It is case-hardened and carefully finished.

ROCHESTER PORTABLE MOTOR

In shops where the individual drive has not yet been adopted, there are times when the shafting of a whole building or, at least, a whole department, has to be kept running in order to furnish power to a single tool on which overtime work has to be done. To meet the demands of one of its customers who was often in this predicament, the Rochester Electric Motor Co., Rochester, N. Y., designed the portable outfit illus-



A Portable Motor for General Emergency Work in Machine Tool Driving

trated herewith. It was so successful that a second was made for the same customer, and since then several have been made for others.

These outfits (see the accompanying engraving) comprise slow-speed motors mounted upon iron trucks, with permanent connections between motor, rheostat, switch and circuit breaker. Heavy clamping terminals permit the motor to be connected up to the service wires very quickly. The design of the truck is such that with the handle in a vertical position, the weight of motor is thrown upon the forward wheels, effectually blocking them. The wheels are mounted on an eccentric axle, so that lowering the handle for moving the outfit raises the weight from the wheels. The forward wheels

are located close together, making it possible to manoeuver the truck in cramped quarters.

The builders also furnish portable trucks with variable speed motors, to be used in case of breakdown of the motors on individually driven machines. One customer has a variable speed motor equipped with a back geared shaft, making it possible to connect quickly with almost any drive in the shop.

MORROW QUICK-RELEASING BALL BEARING CHUCK

As mentioned in a note in the New Tools department of the November, 1908, issue of MACHINERY, the Morrow Mfg. Co., of Elmira, N. Y., makes a ball-bearing drill chuck, so constructed that the knurled sleeve gives positive control to the jaws in all positions, and holds them square with the drill. The provision of the ball bearing makes it possible to get a very firm grip with the jaws with comparatively little effort on the part of the operator. The construction also is such that the driving force exerted on the drill tends to tighten it in place. This tool has recently been improved by the incorporation of a quick-releasing device which permits the loosening of the chuck jaws with a very light twist of the hand, even though the turning force applied to the drill may have tightened the jaws up very strongly. Fig. 1 shows a chuck made on this plan, while Fig. 2 is a sectional drawing illustrating the details of the design.

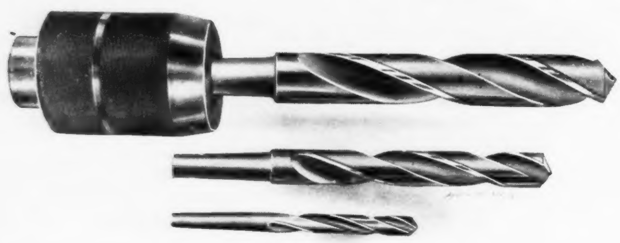


Fig. 1. The Morrow Quick-releasing Ball-bearing Chuck

Referring to Fig. 2, which shows the construction most plainly, A is the body of the chuck, by which it is held in the spindle of the machine. On the nose of A is fitted a revolving sleeve B, held in place by the threaded collar C. A ball bearing and shoulder on A are shown, which serve to retain B and C in place and permit them to be turned easily in tightening the drill, as will be explained later. B is slotted radially to hold three jaws D. An outer sleeve E with an inner taper seat, threaded solidly onto B, furnishes the abutment surface by means of which jaws D are pressed down onto the drill. These jaws have dove-tailed slides machined on their inner faces, which fit radial dove-tailed slots in plate F. This latter has a shank with a short square thread fitting the bore of sleeve G. This sleeve is provided with a fine pitch square thread on the outside diameter, fitting a corresponding seat in body A. A slot milled across the face of sleeve G permits the insertion of a pin H in the shank of F, which is thus allowed a limited rotary movement with reference to G.

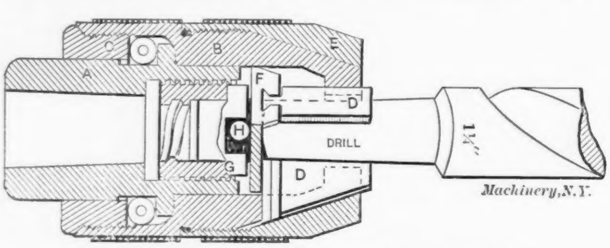


Fig. 2. The Construction of the Morrow Chuck

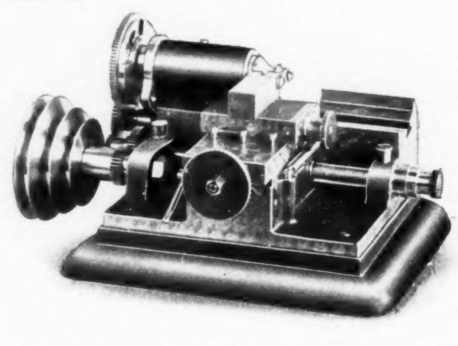
The action of the chuck will now be understood. The drill being inserted in place, the hand of the operator grasps the knurled periphery of sleeves B and E, which revolve together, turning jaws D and with them the plate F to which they are dove-tailed. This, in turn, by the action of the pin H in the slot in G, revolves the latter and screws it out to the right from its threaded seat in body A. This, in turn, forces F and jaws D outward to the right; forcing all the jaws against the inner conical seat of sleeve E simultaneously, thus strongly gripping the shank of the drill. The thrust of the outward pressure of jaws D is taken on the ball bearing between the sleeve C and the shoulder on body A.

In loosening the drill, the workman grasps the periphery of the chuck and turns it in the opposite direction. Parts B, C, E, D, F, H and the drill all revolve together. G remains stationary for the moment, however, since the slot in its face permits a slight free rotation of the pin H. This slight rotation screws inward the coarse threaded shank of F in the sleeve G, withdrawing it rapidly to the left, and loosening the chuck jaws. The lead of the coarse thread on the shank of F is so great that the hand readily screws F back and loosens the drill no matter how tightly the latter may have been held. In tightening the drill in place again, G remains stationary as before until pin H strikes the other side of the slot, when conditions are again as shown in Fig. 2.

This construction gives the greatest facility in handling a chuck of this type without the aid of a spanner or wrench even on sizes running over ½ inch capacity. The particular chuck illustrated (which is known as the makers' No. 5½) was designed to use up drills from which the tangs have been twisted. The body of the chuck is 3 inches in diameter by 4 inches long and will hold Nos. 1, 2, and 3 taper shanks, thus giving a range of drills from ⅛ inch to 1¼ inch which may be rescued from the scrap heap. The chuck will safely hold a 1¼-inch drill to its full capacity without slipping, or straining the hand of the operator. The No. 4 chuck for straight drills takes from ¼ to ¾ inch, and No. 5 from ½ to 1 inch. All parts are hardened and ground accurately to size.

WALTHAM CUTTER TURNING AND BACKING-OFF MACHINE

The machine illustrated herewith is built by the Waltham Machine Works, Newton St., Waltham, Mass., and is intended for the work of turning and backing off minute precision formed cutters.



Lathe for Turning and Relieving Minute Formed Cutters

The machine consists, as may be seen, of a head-stock of the lathe, mounted on a base provided with a cross-slide for the forming tool. The backing off or relieving of the cutter teeth is obtained by a cam on the driving shaft connected to the lower cross-slide by means of a reducing lever. The driving shaft is connected with the work spindle by a train of gears. For the change gears regularly furnished, any number of teeth from 4 to 16 may be backed off. By the use of special gears it is feasible to back off cutters having as many as 20 teeth.

The depth of cut is gaged by a hand-wheel graduated to one-half of a thousandth of an inch, on the feed-screw on the upper cross-slide. The side adjustment of the tool is obtained through the longitudinal slide adjusted by a screw having a hand-wheel graduated to one-thousandth of an inch. Either circular or rectangular tools may be used.

An important feature of the machine is the provision for reversing the head-stock on the bed—that is to say, placing it either to the right or the left of the tool-slide. This permits the cutting of both sides of a cutter with a single tool, thus giving assurance of absolute symmetry in the finished shape of the cutter. As the profile of the bed to which the head-stock is clamped is an arc, having its center identical with that of the work spindle, the reversing of the position of the head-stock has no effect on the distance of the work from the tool. The second setting thus gives the proper

position and the proper diameter of cut to match with the first.

The machine can be used for turning cutter blanks or circular form tools, as well as for backing off teeth. By turning the lever at the left of the cross-slide, the cam becomes inoperative, and when the lower side is clamped by the lever on the right, the two remaining slides can be used the same as a compound rest on the lathe. The machine will hold rectangular forming tools up to ⅜ inch square and circular tools from 1 to 1¼ inch in diameter. Although of small size, the machine is very stiff. The base measures 11 by 14 inches and the net weight is about 100 pounds. The work spindle, cam-shaft bearings, etc., are made of hardened steel, and the finish and workmanship are intended to meet the highest requirements of watch machine construction.

GERSTNER PORTABLE TOOL CASES

H. Gerstner & Sons, 871 Germantown Ave., Dayton, O., are manufacturers of a line of tool-chests and cabinets particularly adapted to the needs of skilled mechanics. They have recently perfected a line of portable tool-cases made in a number of styles and sizes, of which one is here illustrated. Particular features of these tool-cases are their neatness and careful finish, and their compactness. Every inch of available space has been utilized in them, and the tools may be placed in separate drawers where they can be kept in good condition and easily picked out when needed. This gives a much more orderly and systematic arrangement than is afforded by the older style of chests. A convenient feature of style No. 31, shown herewith, is a patent self-hinging lid with a felt-lined tray, which will slide in under the bottom drawer and out of the way if desired, leaving the case in the form of a chest of drawers. When, however, the drawers are closed and the lid is brought up and fastened, the case is safely locked, permitting it to be carried from one job to another with a full kit of tools.

A Leather-covered Portable Tool Case for Machinists' and Toolmakers' Use

These cases are substantially constructed, of seasoned lumber, and are either lock-cornered or dove-tailed, with all parts that are liable to warp well paneled. They are finished in quartered oak, or are covered with the genuine or the best quality of imitation black seal leather. When covered, these cases are also finished in cherry or mahogany if desired. Drawers are lock-cornered and glued, with sheet metal bottoms covered with the best quality of heavy green felt. They are finished with shellac throughout. The trimmings are in harmony with the design, and of sensible construction. They are of highly polished brass, either lacquered or nickeled.

Besides cases and chests for tool-makers and mechanics, this firm makes a line of cases for draftsmen, electricians, and metal-pattern makers. Orders are solicited for special tool-cases, which will be built as desired by the customer in matters of style, size, price, etc.

MOTOR-DRIVEN SPEED LATHE

In the department of New Machinery and Tools in the April and May, 1908, issues of MACHINERY, we described two friction-driven sensitive drill presses manufactured by the Washburn Shops of the Worcester Polytechnic Institute. The satisfactory operation of these tools has led to the adaptation of the same principle to a speed lathe, intended for service on both wood and metals. This lathe is illustrated in the accompanying engraving. The advantages of this particular type of friction drive are the instant control of the speed variation, the starting and stopping of the lathe independent of the motive power, the automatic control of the power transmitted from the driving shaft, whereby the power consumed varies directly as the work requires, and the use of a constant speed motor so that the full efficiency of the motor is available for the slower speeds.

The illustration shows the motor-driven type. The motor is hung from the lathe bed at such an angle that it does not project in front of the bed, and is never in the way of the operator. The power is transmitted from the motor to the main spindle by means of a double roll and disk friction.

Variable Friction Drive Speed Lathe, built by Washburn Shops of Worcester Polytechnic Institute

The pressure of the disks on the rolls is controlled automatically by means of a cam clutch. This cam clutch acts as a positive drive or tightener, and increases or decreases the pull of the disk on the roll directly as the work requires, the pressure between the disks and rolls being very slight except when turning. This construction is the same as used for the drill presses previously described.

The variation of spindle speeds is obtained by throwing the lever near the head-stock. This lever is attached to a segment gear which meshes into a rack cut in the roll carrier, the extreme movement of the rack being only 2 inches to obtain a range of speeds of over 4 to 1. This sliding of the rolls across the disk is easily accomplished, as there is slight normal pressure on the rolls except when the machine is working. The motor is run at 1,800 R. P. M. and the drive is so designed that a speed variation of the spindle is obtained ranging from 600 to 2,650 R. P. M. The spindle is stopped, without stopping the motor, by throwing the speed lever to its extreme position. When in this position, the driver disk is out of contact with the rolls, the disk being recessed for this purpose. This also permits starting the motor without load. The disk on the spindle is wholly enclosed by the head-stock and a moveable cap, and a hand wheel is provided on the end of the spindle for use as a brake and for placing the work. A noticeable feature is the smoothness of operation due to the entire elimination of belts.

The lathe is fitted with either a direct current or induction motor, or a special single-phase motor may be used whereby the lathe can be run from the ordinary lighting circuits. This makes the lathe of special value for house or garage use. The

lathe may also be fitted to run at slower speeds for metal work, and in this case is provided with draw-in chucks and a slide rest.

INGERSOLL COMBINED HORIZONTAL AND VERTICAL SPINDLE MILLING MACHINE

Our readers will remember that we published, as a leading article of the New Tools department in the June, 1908, issue of MACHINERY, a description of a combined horizontal and vertical spindle milling machine built by the Ingersoll Milling Machine Co., of Rockford, Ill. Since putting out this first design, the makers have added certain improvements in mechanism and structure which materially increase the stiffness and convenience of the machine. It is now also furnished in two sizes, thus covering a wider range of usefulness. Figs. 1 and 2 illustrate the two sizes of these machines, while Fig. 3 shows quite plainly the mechanism of the larger of the two.

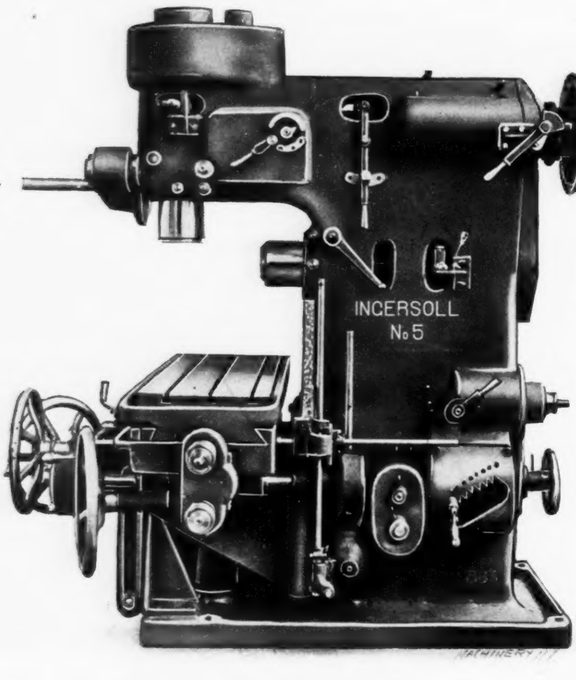


Fig. 1. The Largest Size of the Ingersoll Combined Vertical and Horizontal Column Type Miller

General Construction

A brief general description of the tool will not be out of place before calling attention to the particular points of improvement in the new design. Below the horizontal spindle the machine is similar in appearance to the ordinary column-and-knee type milling machine. Above the horizontal spindle, the column has been brought forward to furnish a housing for the vertical spindle, which is as solidly supported as in any approved type of regular vertical milling machine. This spindle is well out from the face of the column, and a long knee is provided, thus giving a large cross-feed movement. To prevent this from weakening the machine, heavy knee supports are provided on the No. 5 size.

The machine is gear driven throughout, both as to speeds and feeds, the latter being taken (as required by modern practice) from a constant speed driving shaft. Longitudinal, cross and vertical power feeds are provided, all reversible and all controlled by automatic stops.

Changes in the Drives

Perhaps the most radical change in the new design is in the spindle driving mechanism. This, as may be seen in Fig. 3, provides for 16 changes of speed, applicable alike to the vertical and horizontal spindles, the final or "back-gear" change for the two spindles being independent. Fig. 3 shows a motor-driven machine. In the belt-driven machines, such as shown in Figs. 1 and 2, the driving gear *A* is replaced by a constant speed pulley. The inner surface of the flange of this gear or pulley (as the case may be) forms a seat for the conical clutch member *B*, which is pressed into engagement by a spring as shown, and is thrown out of engagement by lever *C*. This clutch and spring furnish a safety device to limit the driving power to a point which the machine will safely stand. Four gears *D* on the constant speed driving shaft mesh with four mating gears *E* on the variable speed shaft *F*. This latter is shifted axially by a lever having four positions, as shown just at the right of the vertical spindle in Fig. 1. It carries clutch teeth engaging corresponding internal clutch teeth on extensions of gears *D*, so that each of its four positions gives the corresponding one of four changes of speed.

On shaft *F* are also keyed the double gears *G*, which engage corresponding gears *H* on shaft *J*. Shifting gears *G* by the lever shown entering an opening at the top of the column in Fig. 1, doubles the four speeds previously obtained. Shaft *J* is connected by bevel gears as shown with the back-gearing *K* on the vertical spindle, where the eight speeds previously obtained are doubled to 16 by the shifting of the clutch sleeve *L*, to engage either upper or lower gear *K* with the vertical spindle. In a similar way shaft *J* is connected by a train of spur gears with similar back-gears *K* and sliding sleeve *L* on the horizontal spindle. The handles for throwing the back-gears are plainly shown in Fig. 1, and this back-gear mechanism is the same as described for the earlier machine; as is, also, the axial adjustment provided for each of the two spindles and the form of spindle bearings used.

The older machine gave four changes of speed only from the driving shaft instead of the 16 here provided. The new design thus obviates the necessity of speed changes in the counter-shaft, and permits the use of a constant speed motor drive.

The Feed Mechanism

Instead of being driven by a chain, the feed mechanism is connected with the constant speed shaft by a vertical shaft *M* and bevel gears. The same frictional spring driving device *N* is used to prevent breakage of the feed mechanism. The gear box, which is inclosed within the column of the machine, is of the familiar tumbler gear type, with added changes by means of shifting gears and clutches giving 16 variations for the No. 3 machine and 32 for the No. 5 machine.

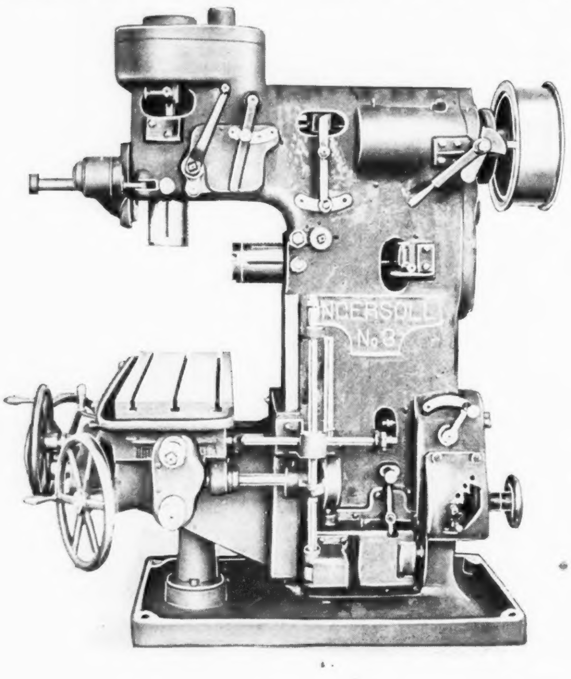


Fig. 2. The Smaller, or No. 3, Size

All the feeds are reversed from the bevel gear reversing mechanism at *O*. The reversing clutch at this point is operated by the vertical rock shaft *P* which is geared with the horizontal rock shaft *Q*, and connected by a reach rod with the reversing lever *R* at the front of the knee. The regular stop dogs on the front of the table operate this reversing lever for stopping the longitudinal feed in either direction. The stops for the automatic cross-feed are shown at *S* and *S*. They are adjustable on rock shaft *Q*, and by means of in-

clined cam faces acting on similar engaging faces on stationary support *T*, shaft *Q* is rocked at the extremes of the desired movement; this, through the connections described, throws the reversing clutch to the central or off position. Similar adjustable dogs *U* on the vertical rod *P*, engage corresponding cam faces on *T*, and furnish the automatic stop for the vertical travel of the knee. Slip clutches are provided at the various feed screws for connecting each of the feeds in the three directions, and hand-wheels are conveniently placed for operating them manually without interference with each other.

Minor improvements in construction that will be noticed are the more rigid design of the overhanging arm, the more compact arrangement for the machine as a whole in spite of the stockier design, and the convenient provision for motor driving when desired, as shown in Fig. 3. It should also be mentioned that a spring counterweight is provided for the knee of the No. 5 machine.

Dimensions and Range of Feeds

The following dimensions will give an idea of the capacity of the two sizes of this machine. The No. 3 machine has a table whose working surface is 14 inches wide by 48 inches long. The longitudinal feed is 39 inches, the cross-feed 11, and the vertical feed 15 inches. Sixteen changes of feed are provided ranging from ½ to 20 inches per minute. The spindle is of open-hearth crucible steel, running in phosphor bronze bearings, and has a No. 12 Brown & Sharpe taper hole. The 16 spindle speeds range from 13 to 350 revolutions per minute. The table will take in 23 inches under the vertical spindle, as a maximum, and 2 inches as a minimum. The distance from the center of the horizontal spindle to the top of the table ranges from 15 inches to 0. The distance from the center of the vertical spindle to the face of the column is 16 inches. The shipping weight of the machine is about 7,500 pounds.

The corresponding dimensions for a No. 5 machine are as follows: The working surface of the table is 20 by 60 inches, and the longitudinal, cross and vertical feeds are 59, 15 and 16 inches respectively. Thirty-two changes of feed, varying from ⅝ inch to 24 inches per minute, are provided. The spindle has a No. 16 Brown & Sharpe taper hole. The spindle speeds are the same as for the smaller machine. The capacity of the table under the vertical spindle ranges from 26 inches maximum to 4 inches minimum. The distance from the top of the table to the center of the horizontal spindle ranges from 16 inches maximum to 0 minimum. The center of the vertical spindle is 20 inches from the face of the column. The shipping weight is about 15,400 pounds. A circular table with automatic feed will be provided for either of these machines at an extra cost.

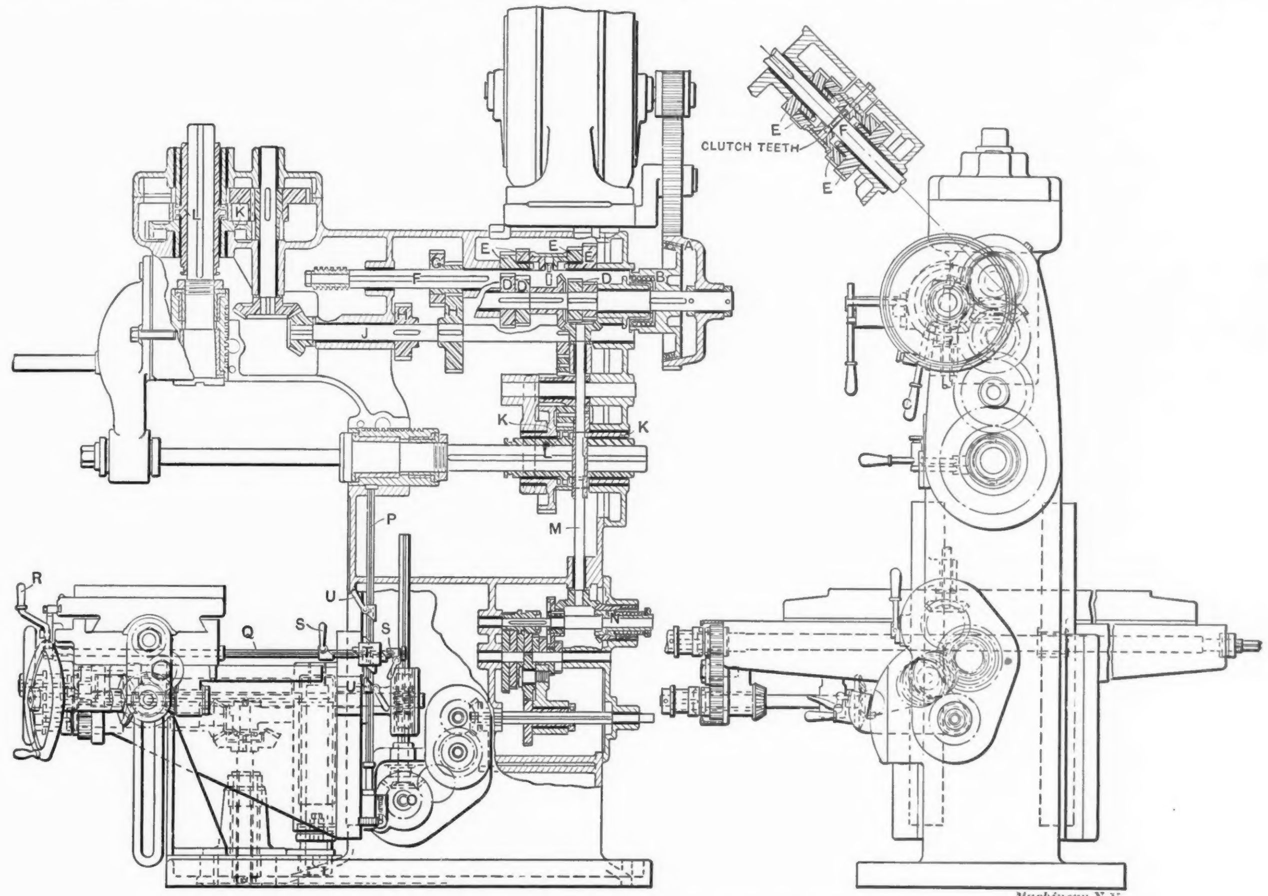


Fig. 3. The Feed and Drive Mechanism of the No. 5 Machine

OBERMAYER BLUE LEATHER BELLOWS

The ordinary bellows used by foundry men gives a great deal of trouble from the cracking of the leather which, being the most vulnerable part of the tool, shortens its period of usefulness. The Obermayer Co., of Cincinnati, O., has succeeded in producing a bellows with a specially prepared leather, which is unusually soft and pliable, thus doing away with most of the danger of cracking. The treatment which the leather receives gives it a deep blue color and this, in combination with a careful oil-soaking process, produces the required flexibility. The bellows is strongly made in all respects. It is fitted with a short steel spout which will not be crushed, broken or rusted, in the treatment ordinarily received around the foundry.

FRANKLIN MOORE CO.'S IMPERIAL HOIST

The Franklin Moore Co., of Winsted, Conn., has designed and placed on the market a chain hoist with a number of innovations which tend to increase its strength, efficiency and general handiness. Among other improvements is a new method of supporting the load sprocket from the hook, and an improved brake mechanism. The construction also permits a very compact design, requiring small head room, and gives a total weight for the apparatus which is considerably less than for older designs of the same capacity.

The general appearance of the Imperial hoist is shown in Fig. 1, while the details of its construction will be plain from the line engraving, Fig. 2. The hand chain wheel *A* is connected (through the brake mechanism) with shaft *B*, which has formed on it a pinion *C*, meshing with similar gears *DD* on a pair of similar intermediate shafts *E*. Shafts *E*, in turn,

carry pinions F, which mesh with the large gear G on the load sprocket shaft. This latter is supported on roller bearings in hangers H, to the upper end of which the hook J is pivoted. It will thus be seen that the load is supported from sprocket K through hangers H to the hook, without putting any strain whatever on the cast iron casing of the hoist. These hangers or yokes are made of steel. This avoids the possibility of an accident due to imperfect castings—a risk which is always taken where the top hook is fastened to the housing. The method of gearing employed effects a considerable reduction in friction loss as well, since the housing or casing is free from strain, permitting all the other shafts and gears to run freely. This, in combination with the ball bearing support of the load shaft, gives a high hoisting speed with comparatively little force exerted by the operator. The fact that the load is supported so directly also, without requiring a heavy, strong casing, explains the reason why the hoist can be made compact and of light weight.

Fig. 1. The Imperial 2-ton Chain Hoist

The operation of the brake will be easily understood from Fig. 2. In hoisting a load the direction of rotation of the sprocket wheel A is such that it is screwed on threaded shaft B toward the right, tightly clamping leather washer M between friction members N and O, so that A, M, N, O and shaft B revolve together as one member. If now the operator releases the hand chain, the tendency of the mechanism would be to run back, if the load is heavy enough. This is prevented, however, by the fact that friction plate N is provided with a ratchet mechanism (not shown in the engraving) which prevents it from rotating backward, and as A, M, N, O and B are all clamped together, the load is held stationary. If sprocket wheel A is rotated backward by hand chain

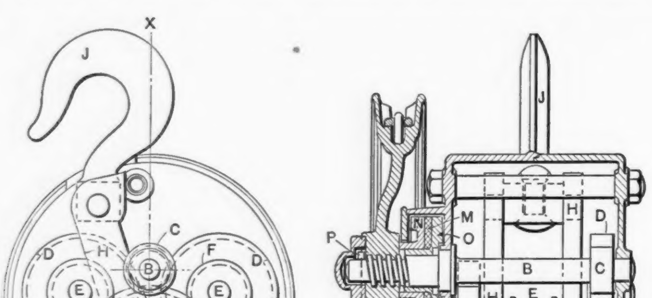


Fig. 2. Mechanism of the Imperial Hoist, showing Improved Brake and Suspension

to lower the load, it is first unscrewed to the left on the threaded shank of shaft B, thus releasing friction surfaces M, N and O, and permitting the work to descend in spite of the stationary disk N, as long as hand wheel A is revolved. When this is again left stationary the rotation of B under the influence of the load, screws it into the hub of A, thus again drawing the surfaces on M, N and O into tight contact, and stopping the rotation against the stationary disk N. Pin P prevents A and B from unscrewing more than is necessary to give a free but easily controlled descent. The load thus descends rapidly and smoothly and with perfect safety.

Great pains have been taken in the construction of this line of hoists in the matter of selecting suitable materials which would give satisfactory wear under the continued abuse to which chain blocks are subjected. The working parts are accurately made on high-class machinery, and are all thoroughly protected by the enclosed two-piece housing provided. The Imperial hoist is made in a number of sizes, ranging from ½ to 20 tons capacity.

BLEVNEY AUTOMATIC POLISHING MACHINE FOR FINISHING PUNCHINGS

John C. Blevney, 216 High St., Newark, N. J., has built for some years a form of polishing machine, which has come into extensive use for finishing metal surfaces of all kinds. The distinctive feature of this polishing machine is its use of two belts. The inner belt is usually made of leather, perforated and ribbed, as described later, to give a better grinding action. This inner belt does the driving. The outer belt is composed of emery cloth and rides over the lower belt, passing around one of the two pulleys on which the latter is carried, and then over an idler of its own, by means of which the proper tension is maintained on it irrespective of the heavier tension given to the driving leather belt. This construction, originally applied in the regular vertical machine of the builder, can easily be followed in the horizontal arrangement of the automatic machine illustrated in Figs. 1 and 2.

Arrangement of Driving Belts

In arranging this machine for the automatic finishing of punchings and other flat steel parts, the belts were arranged

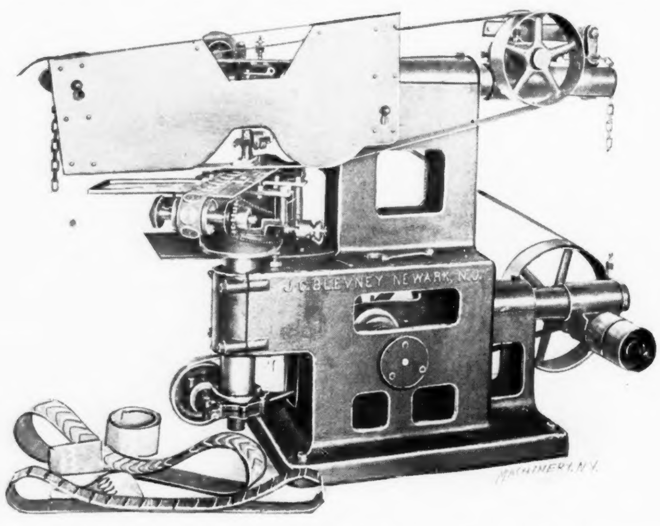


Fig. 1. Blevney Horizontal Grinding and Polishing Machine, with Automatic Belt Feed

to run horizontally in order to design the feeding mechanism to the best advantage. The structure of the machine is of a light but rigid design, and carries stiff cylindrical bars on which the various idler and driving pulleys and other operating mechanisms are adjustably mounted. The driving belt from the main line-shaft is led to tight and loose pulleys at the right of the base of Fig. 1. The counter-shaft on which these pulleys are mounted is adjustable on the bar by which it is supported to give the proper tension to the driving belt; this latter extends diagonally upwards in Fig. 2 to the driving shaft of the polishing belts. The driving shaft is mounted on a fixed support clamped to the upper bar as shown, and it carries on its other end a pulley for driving the inner or leather belt of the double belt system. This passes over an idler at the right of Fig. 2. This idler pulley is mounted in adjustable bearings and the proper tension on the belt is maintained by the lever and weight shown, acting through the chain connection with the sliding journal support. The grinding belt proper, of emery cloth, lies over the leather belt and extends back to the idler at the left of Fig. 2. This idler is also mounted on a sliding journal in the upper bar, and is provided with a lever and weight arrangement for giving it the proper tension. This tension is less, of course, for the emery cloth than for the leather belt.

Feed Mechanism

So far the general arrangement of the machine is identical with that for the original vertical design. The improvement consists in the addition of the automatic feeding mechanism shown. This consists of a holder provided with driving and idler pulleys so mounted as to rotate a leather feeding belt across the under surface of the grinding belt. The frame in which these feed belt pulleys are mounted can be adjusted so that the belts cross each other at any desired angle, thus giving an opportunity to cross the grinding marks when roughing and finishing cuts are taken. On the feeding belt are riveted suitable metal strips or pins for confining the punchings or other parts which are to be finished. The movement of the feeding belt is continuous, being driven by the chain and sprockets shown in Fig. 1, operated by bevel and spur gearing from a vertical shaft through the center of the column on which the mechanism is mounted. Connection with the counter-shaft at the rear of the machine is made, as shown in Fig. 2, by a pair of three-step cone pulleys, which provide means for varying the rate of feed.

The operator sits at the front of the machine (Fig. 1) and places the punchings in the holders on the constantly moving feed belt. The mechanism is carefully guarded on the operator's side, by the removable sheet iron guard shown. The machine has a capacity for finishing punchings of 1 square inch surface at the rate of 4,000 per hour.

Pressure for polishing is produced by the spring and weight

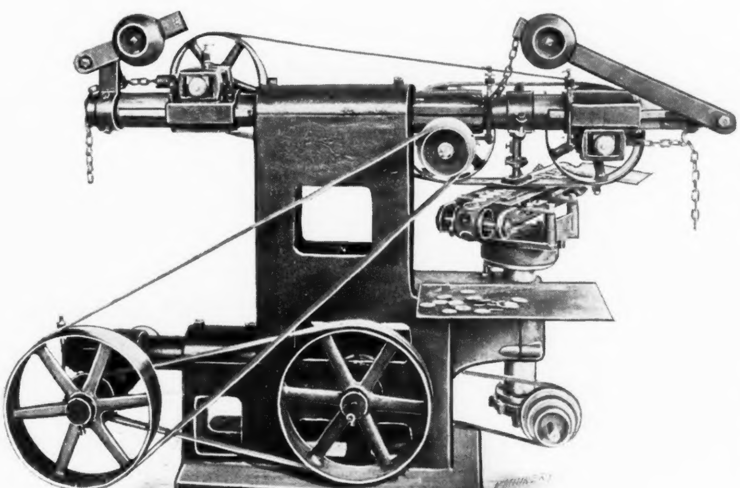


Fig. 2. Rear View of Machine, showing Drive and Tension Mechanism

controlled presser-plate, shown immediately above the belt in Figs. 1 and 2. A latch is provided for raising this plate off the belt when no work is beneath it and a stop is also furnished to limit the thickness to which the work is ground, and to prevent, as well, the grinding of the feed belt and its holders when no work is passing through the machine. The feed belt itself runs on a metal plate. The surfaces finished are thus true with each other, the belts being held between two flat metal surfaces.

Construction of Belts

The construction of the belts is interesting in a number of respects. The inner or driving belt is usually made of leather, ribbed as shown in the sample on the floor at the base of the machine in Fig. 1. This ribbing raises corresponding ribs in the thin emery cloth belt which runs over it, giving alternate grinding and relieving surfaces to the belt; this gives provision for taking care of the dust produced by the grinding, and prevents clogging with grains of emery, as would be the case if its surface were smooth and unbroken. In this respect the action of the ribbed belt is similar to that of the grooved surface so largely used for disk grinders, though it has the advantage over the latter that the ribs constantly change position, as the emery belt is constantly changing its position with relation to the leather belt by which it is driven. The dust which collects in the recesses between the ribs is easily thrown off on the revolving pulleys, and the belt is kept cool as well by its rapid motion.

For accurate flat grinding the inner leather driving belt may be replaced by an endless steel belt. This, however, does not give so good a cushion for polishing as leather. An improved form of joint is used in forming the light emery belts. This joint is shown in the section of belt on the floor in Fig. 1. It consists of a series of interlocking fingers cut from each other in the belt, inserted in each other, and then glued and

A Friction Roller Attachment for Making Fine Adjustments on the Beam Caliper

dried under pressure. This results in a joint as strong as the original belt, and at the same time of the same thickness, if properly pressed. It is made without waste of stock. The belt in the foreground is a feed belt for plain washers of a considerable range of diameter; these are inserted between the tapering steel plates provided.

Besides the automatic features in this particular machine, this system of grinding offers evident advantages in the way of rapidity of action, simple use of the emery cloth, and provision for the rapid change of grinding material. The bearings are dust-proof and the machine is strongly driven. The maker is prepared to furnish machines of the same principle constructed for the hand or automatic finishing of almost any work for which polishing by emery cloth is adapted.

IMPROVED ADJUSTMENT FOR COLUMBIA CALIPERS

The E. G. Smith Co., 134 No. 3rd St., Columbia, Pa., maker of the well-known "Columbia" line of machinists' tools, has recently improved the standard beam caliper, as shown in the accompanying engraving, by the addition of an ingenious attachment for making fine adjustments. This new attachment, which the makers call the "fine roll," is exceedingly simple. It consists of a roller straddling the scale, and pulling the sliding head along forward or backward as required. It does this very smoothly, and delicate adjustments can be made with much greater rapidity and ease than with the old style adjusting screw. This attachment is furnished with any of the maker's calipers.

"DUQUETTE" TWO-WAY PIPE WRENCH

The chain pipe wrench shown herewith is made by the Toledo Wrench Co., 1507 Nicholas Building, Toledo, O., and is known as the "Duquette" two way pipe wrench. Three im-

A Chain Pipe Wrench whose Action is Reversible

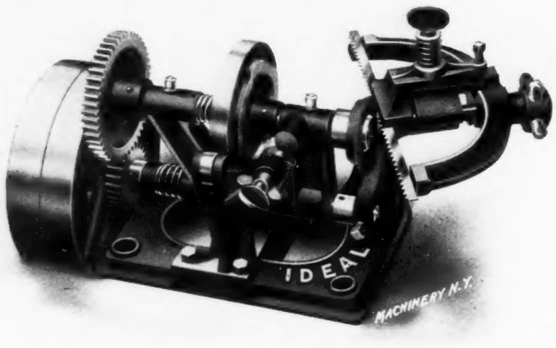
portant improvements are offered in its design. First, it has a positive two way action. It works like a ratchet in either direction, grips the work instantly, and can be reversed immediately. The annoyance arising from a crossed thread in starting a jointed pipe is quickly overcome; no re-adjustment of the chain is necessary. The second advantage is that this

wrench has no teeth, yet it will take a tight grip on an oil covered nickel pipe without crushing or marring the surface. In the third place, being of the type in which pressure is applied practically throughout the whole circumference of the pipe, there is no tendency to crush rusty spots in old pipes, or to open new pipes at a seam, as sometimes happens. The head portion of the handle, in connection with the inner surface of the chain links, gives practically a true circular pressure about the work, exerting a uniform pressure. The wrench releases immediately when the pressure is removed, but will bite again and not slip so long as force is exerted. All parts of this tool are well made and are interchangeable. Being suited to a wide range of work, it should find ready appreciation with mechanics in general.

ROTARY FILE AUTOMATIC BAND SAW SHARPENER

The accompanying illustration shows a band saw filing machine made by the Rotary File & Machine Co., 589 Kent Ave., Brooklyn, N. Y. It is a new design of filing machine which has been built for some years, and which has met with a high degree of appreciation among users of band saws. The tool is chiefly remarkable for the simplicity with which it performs a somewhat complicated operation. The file itself is circular and revolves continuously. It has file teeth cut for about three-quarters of its periphery, the remaining part being smooth. The file teeth are cut at such an angle as to give very efficient action. The smooth portion of the file is used in feeding the saw, as will be described.

The machine is driven from the tight and loose pulleys at the left. The driving-shaft is connected by gearing with the cam-shaft above it, which is mounted in bearings on arms swinging about the driving-shaft as a pivot. The cam has acting surfaces on its periphery and on its face. The surface on its periphery bears against a roll on the stationary stand bolted to the base, so that the cam-shaft is thus rocked in toward and out away from the saw. The cam surface on the face bears against a similar roll pivoted on the stand, and gives the cam-shaft an axial movement. These axial and rocking movements are, of course, imparted to the file itself, which is mounted on the cam-shaft.



A Band Saw Sharpener of Noticeable Simplicity

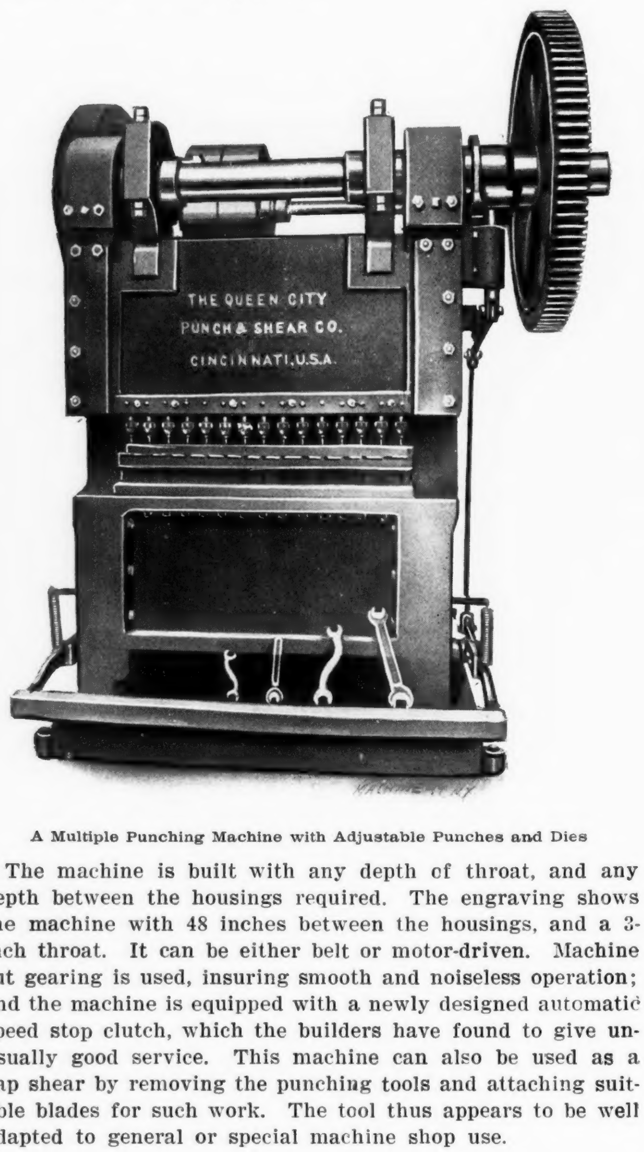
The saw is held in the frame shown, being guided by the ledges on which it rests. It passes through the adjustable friction clamp in the center of the frame, which gives the proper tension for holding the saw during the filing, and still permits it to be fed forward without binding. The holding frame may be swung about its pivot to change the angle of the tooth, and may be adjusted in and out to agree with the width of the saw blade.

The operation of the machine is as follows: Considering that the blade is in proper position, the file, as it revolves, is forced into the tooth, cutting the worn metal away and sharpening it to give a new cutting edge. The face and periphery cams then swing the file out and back, dropping it into the next tooth of the blade; by the continued action of the cams, the rotating file is properly placed in this tooth and the blade is pushed forward by the file until the position occupied by the preceding tooth is reached. This pushing of the blade is done on the smooth portion of the periphery of the file. The cutting does not commence again until the blade is fed forward as described. Suitable adjusting screws regulate the movements of the cams, which may be varied to suit saws of different width and pitches.

The concave face given to the tooth by the file is said to be much superior to the convex surface given by the hand operation, even when the latter is skillfully done. It is claimed, also, that the cost of files is reduced by the use of this machine.

QUEEN CITY MULTIPLE PUNCH

The accompanying illustration shows a multiple punching machine recently built by the Queen City Punch & Shear Co., of Cincinnati, O. It is well adapted to general work, owing to its large capacity and convenience of arrangement. The punches and dies are interchangeable, and can be spaced in any position required by the work to be done. The capacity of the tool permits the punching of fifteen ¼-inch holes in ¼-inch material, in one operation.



A Multiple Punching Machine with Adjustable Punches and Dies

The machine is built with any depth of throat, and any depth between the housings required. The engraving shows the machine with 48 inches between the housings, and a 3-inch throat. It can be either belt or motor-driven. Machine cut gearing is used, insuring smooth and noiseless operation; and the machine is equipped with a newly designed automatic speed stop clutch, which the builders have found to give unusually good service. This machine can also be used as a gap shear by removing the punching tools and attaching suitable blades for such work. The tool thus appears to be well adapted to general or special machine shop use.

TWENTY-ONE INCH SNYDER UPRIGHT DRILL

J. E. Snyder & Son of Worcester, Mass., have placed on the market the 21-inch drill shown in the accompanying engraving. As may be seen, it is a rugged and business-like appearing tool, and is capable of doing heavy work for a machine of its size. It has sufficient driving power to drill 1¾-inch holes in cast iron, or 1¼-inch holes in solid machinery steel. It has a wheel and lever feed combined, and a power feed with automatic stop. The whole driving mechanism, including the bevel gearing and the belt area, has been designed for heavy service.

The following dimensions will give an idea of its size and capacity. The height from the floor to the upper cone pulley is 21 inches. The machine will take 26 inches between the

table and the end of the spindle, or 43½ inches on the base. The table is 17 inches in diameter, and the main column 6 inches. The driving pulleys are 11 inches in diameter for 2½-inch belt, and the cone pulleys range from 4¾ to 10 inches for the same width of belt. The spindle, in the sleeve, is 1½ inch in diameter. It has an automatic feed of 8 inches, and has a No. 3 Morse taper hole. The weight of the machine is about 900 pounds. It is shown here arranged for motor-drive,

A 21-inch Drill of Rugged Design

using a 1-H.P., 220-volt, General Electric direct-current motor. It is regularly furnished for tight and loose pulley drive.

At the Mechanical and Electrical Exhibition recently held in Worcester, this tool attracted considerable attention. It was tested by drilling seven ⅝-inch holes in 1⅛-inch solid cast iron, doing this in 30 seconds with the lever feed. The operator was unable to stall the machine, though using his whole weight on the lever.

"VIXEN" HAND MILLING TOOL

In the department of New Machinery and Tools in the September, 1908, issue of MACHINERY, we described the "Vixen" patent milling file. The maker of this file, the National File & Tool Co., 110 Allegheny Ave., Philadelphia, Pa., has recently adapted this style of file to be used as a hand planing or surface milling tool for metal.

The "Vixen" Milling File adapted for use as a Hand Planing or Surfacing Tool

As may been seen in the engraving, the construction is very simple. A strip of hard wood is provided with a convenient metal handle, and a small projecting front hook to assist in guiding the stroke. Attached to the lower side of this wooden strip, by bolts as shown, is a "Vixen" milling tool or file blade. When so held, this blade is in convenient form to use on all sorts of surfacing operations on all sorts of materials, such as steel, iron, copper, tin, babbitt, aluminum, bronze, marble, etc. The peculiar shape and cutting actions of the teeth have been explained before. Suffice it to say that they are machined instead of being struck by a chisel, and that carefully shaped and very efficient cutting teeth are thus obtained. This surface milling tool is furnished in 8, 10, 14, 16 and 18-inch lengths.

TAYLOR & FENN TYPE C MANUFACTURERS' DRILL

The manufacturers' sensitive drill made by the Taylor & Fenn Co., of Hartford, Conn., is now furnished with a simple and effective design of power feed when so desired. The drill press provided with power feed is called by the makers the "Type C." It is illustrated in Figs. 1 and 2.

The general features of the Taylor & Fenn sensitive drill are well known. In the multi-spindle style shown in Fig. 1 the separate columns are adjustable on the top of the base to any desired center distance within the limits of adjustment required for the machine. Each separate column carries a complete driving mechanism, with a geared variable speed drive, operated by the lever seen projecting from the gear box at the rear in Fig. 2. A vertical variable speed shaft passes up through the center of the column, and is

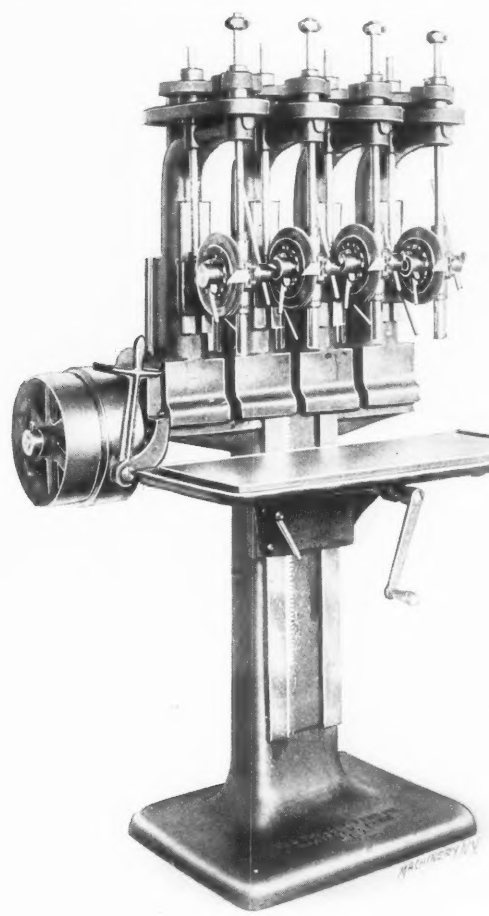


Fig. 1. Taylor & Fenn Multiple Spindle Sensitive Drill with Power Feed

connected with the drill spindle by a chain and sprocket wheels at the top. This chain is shown provided with a guard.

The details of the automatic feed are best seen in Fig. 2. A vertical worm-shaft is geared with the spindle at the top of the column. Two rates of feed, one of 0.0071 and the other 0.0096 inch per revolution of the spindle, are provided by loosening the nut on the intermediate gear stud and reversing the compound connecting gear. The worm on the vertical shaft engages a worm-gear with a bronze rim and a hardened steel center, in which notches are cut to form a clutch ring for receiving the driving lever. The worm-wheel runs free on a bronze bushing when the driving lever is disengaged. It always remains in mesh with the worm, so that the wear is evenly distributed over all the teeth. The driv-

ing lever is fastened to a clamp collar that fits on the end of the feed pinion shaft, which is octagon in shape, permitting of eight settings of the feed lever. If it is desired to shorten or lengthen the range of feed, it may be quickly accomplished by loosening the binder screw on the clamp collar, slipping it off and replacing it into position so that the lever shall have minimum travel to the knock-off. The lever is disengaged from the clutch ring by means of a hardened knock-off, which has an adjustment greater than the distance between the notches on the clutch ring, and may then be set to drill holes of a given depth with great accuracy.

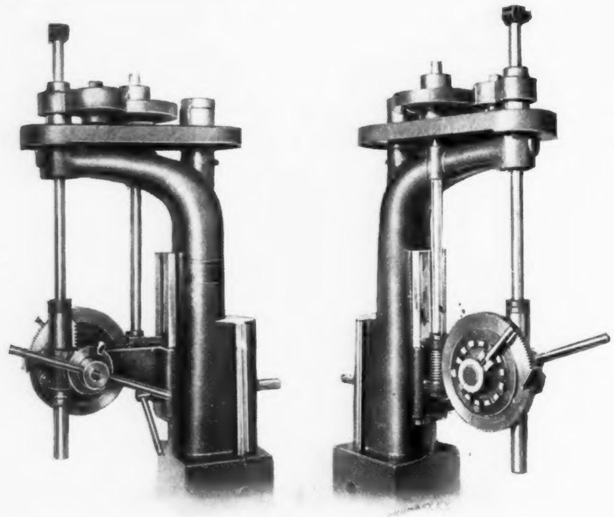
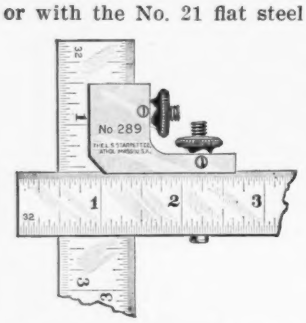


Fig. 2. The Mechanism of the Power Feed

The "Type C" drill press illustrated herewith is the same as the regular "Type A" machine, with the addition of the automatic power feed. The separate spindle columns are interchangeable with all the other types, and may be used in combination with any of them on the same base. This same power feed may also be applied to one spindle of the "Type B" machine which was illustrated in the New Tools department of the January, 1909, issue of MACHINERY. By this means all the spindles are fed simultaneously. The power feed may at any time be disengaged and the same lever feed used as in the ordinary "Type A" machine.

AUXILIARY SCALE ATTACHMENT FOR STARRETT SQUARES

The attachment shown herewith is furnished by the L. S. Starrett Co., Athol, Mass., for use with the 12-, 18- and 24-inch blades of the No. 11, 23 and 33 squares. It can be used with any of the makers' regular rules up to 1 inch in width, or with the No. 21 flat steel square as well.



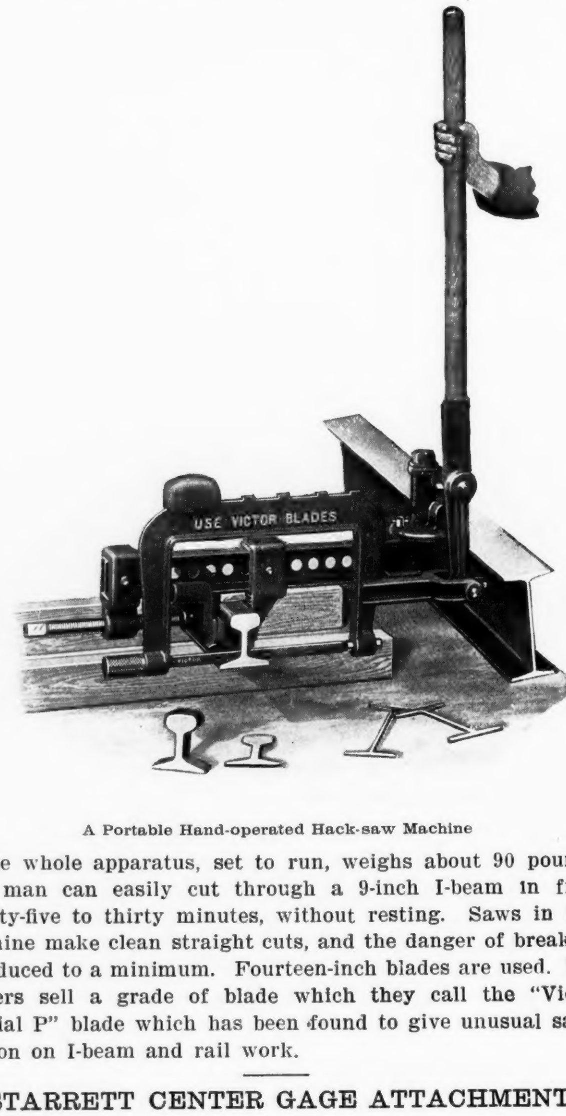
A Device for Clamping together Scales and the Blades of Squares

The ways in which it may be used will readily be appreciated. It is shown in the engraving holding two rules or blades together at right angles. Either of these may be adjusted in relation to the other for any dimension within their range. The blades are held squarely at right angles to each other. This device increases the usefulness of the combination square in laying out centers, or in scribing lines at right angles to each other, but at a given angle with a reference surface. They also convert the combination square into a height gage or beam caliper, and extend its usefulness in many other directions which will readily be appreciated by the mechanic who uses it.

M. S. W. PORTABLE HACK-SAW MACHINE

The Massachusetts Saw Works of Chicopee, Mass., has designed a portable hack-saw machine for use in cutting rails, I-beams and other steel shapes, in place. Such work hitherto has either been done by a portable circular saw machine, or by the ordinary hand hack-saw, generally operated by two men. The ordinary portable saw has the disadvantage of requiring two or three men to set it up and operate it, and it is troublesome as well in the matter of keeping the saws in the proper condition. The hand hack-saw is a slow and tedious device. It takes experienced men to cut through an ordinary rail or I-beam without breaking several blades, and it takes conscientious men to work on such a job without doing more or less loafing.

The attachment shown in the accompanying engraving uses the hack-saw under the best conditions. The clamp is universal, and may be easily adjusted to any steel shape, or to almost any kind of miscellaneous work it may be desired to saw. The saw is operated by a long handle, so that the workman stands or sits in the position most convenient for protracted exertion. This handle is mounted on a pivoted base, so that cuts may be taken at any desired angle. The frame itself is solid and substantial, and is provided with an adjustable weight for giving a suitable and even rate of feed.

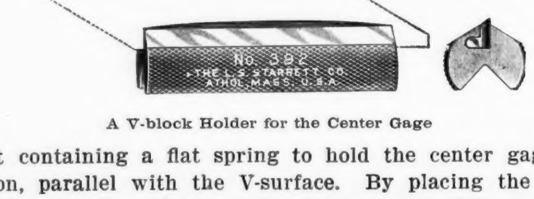


A Portable Hand-operated Hack-saw Machine

The whole apparatus, set to run, weighs about 90 pounds. One man can easily cut through a 9-inch I-beam in from twenty-five to thirty minutes, without resting. Saws in this machine make clean straight cuts, and the danger of breakage is reduced to a minimum. Fourteen-inch blades are used. The makers sell a grade of blade which they call the "Victor Special P" blade which has been found to give unusual satisfaction on I-beam and rail work.

STARRETT CENTER GAGE ATTACHMENT

The center gage attachment shown herewith is made by the L. S. Starrett Co., Athol, Mass. It consists of a V-block, with



A V-block Holder for the Center Gage

a slot containing a flat spring to hold the center gage, by friction, parallel with the V-surface. By placing the block against the lathe spindle or face-plate, a threading tool can

be adjusted in proper alignment to cut both sides of a thread to the exact angle, for either external or internal work. The V-block will be found convenient for lining the attachment on arbors or other cylindrical pieces. The attachment is adapted to holding the gage either by the side or end, in any position required for the work in hand.

FOSDICK MOTOR-DRIVEN HORIZONTAL BORING, DRILLING AND MILLING MACHINE

In the October, 1908, issue of MACHINERY, in the department of New Machinery and Tools, we illustrated the No. 0 horizontal boring, drilling and milling machine made by the Fosdick Machine Tool Co., of Cincinnati, O. Provision has recently been made for equipping this boring machine with constant speed motor drive, as shown in Fig. 1. The speed box used is of the tumbler gear type, and is equipped with steel gears throughout. There are four changes made through the tumbler gears, and two changes made through the back gears in the speed box, making a total of eight changes of speed. The slow speed change is made through a pair of tool steel clutches, 4 inches in diameter, and the high speed change through a powerful friction clutch, 5½ inches in diameter. These changes are controlled by a lever shown running to the front of the machine, which can also be used for starting and stopping. A 5 H.P. constant speed motor, 1,000 R.P.M., is used, geared direct to the drive shaft through a pair of spur gears, the pinion of which is of rawhide, brass mounted.

In using a variable speed motor, the equipment is similar to that shown, with the exception of the speed box and the controller. A drum type of controller is used on the variable speed motor drive, mounted on the head, where the speeds can be easily controlled from the front of the machine. The lever for starting, stopping or making the back gear changes, is in the same position as shown for the constant speed drive.

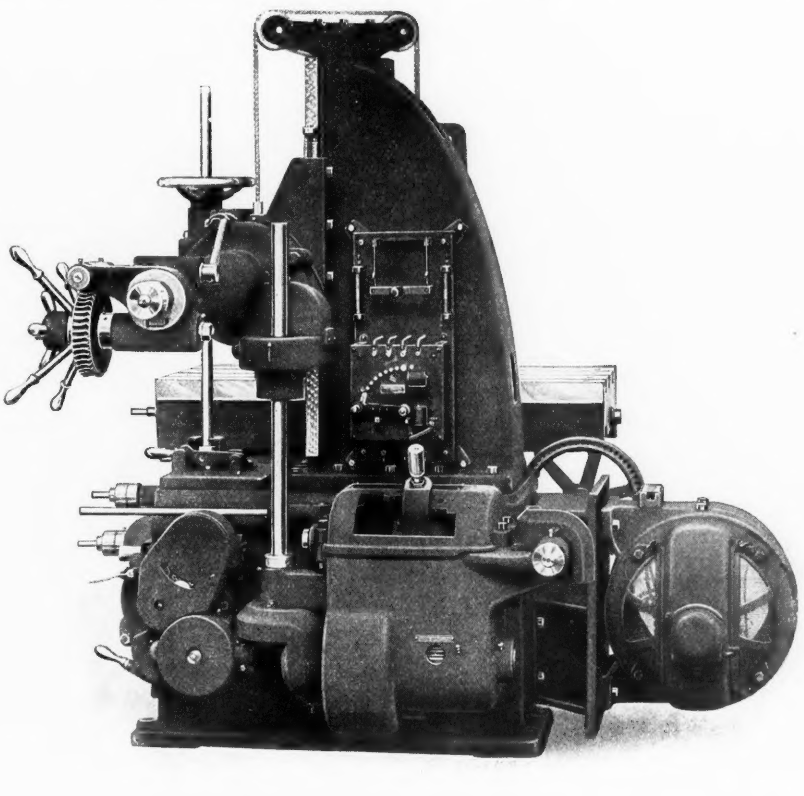


Fig. 1. Arrangement of Drive on Fosdick Boring Machine, for Use with Constant Speed Motor

Fig. 2 illustrates three recent attachments provided for this machine. The star feed facing attachment can be bolted directly to the spindle sleeve, or clamped in any desired position on the spindle itself. It will face work up to 18 inches in diameter. The auxiliary table is used for overhanging parts of any kind, which may be bolted to it, or allowed to slide on it with the adjustment of the main table. It is 8 inches wide and 48 inches long, and is provided with a T-slot for its full length. The swiveling table shown may be revolved by hand or by worm-wheel movement as desired; the worm and its hand-wheel may be withdrawn, leaving the table free. Four tightener bolts are provided for securely fastening the rotary platen to the base-plate when the adjustment has been made. The base-plate in turn is tongued and bolted to the

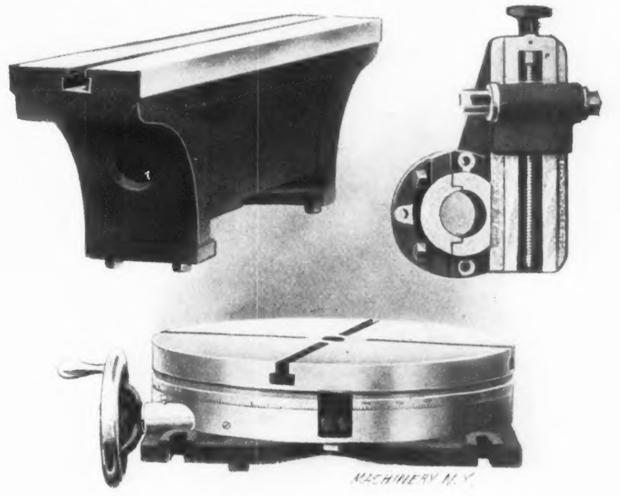


Fig. 2. Auxiliary Table, Facing Attachment, and Revolving Table for Boring Machine

cross-table of the machine. This table is graduated to ½ degree. It is 24 inches in diameter and 6 inches high, with an accurately bored center hole for arbors and plugs. Four cored T-slots are provided in the top surface.

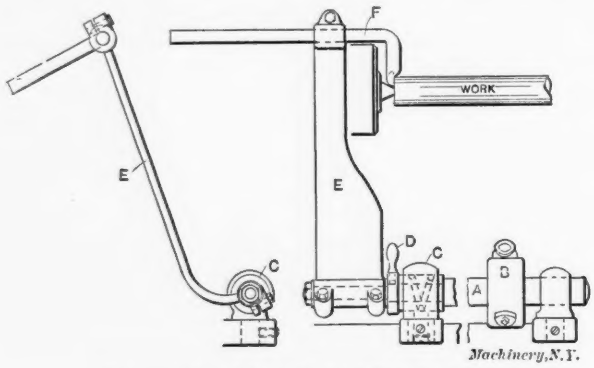
COMPENSATING AUTOMATIC STOP FOR "LO-SWING" LATHE

The well-known "Lo-Swing" lathe built by the Fitchburg Machine Works, Fitchburg, Mass. (see description in the November, 1905, and September, 1907, issues of MACHINERY, has recently been equipped with the improved stop motion illustrated herewith. The particular point of advantage in the construction of this stop motion is its provision of means for stopping all the cuts taken on the machine at a desired distance from the head-stock end of the stock, no matter what the depth of the centering may have been; or the desired shoulder distances may all be cut to dimensions measured from the deepest point of a rough or irregular end; furthermore, the mechanisms makes provision for stopping the cuts automatically at desired distances from shoulders turned in previous operations, on cuts taken from the opposite end of the stock.

In the illustration, A is a stop rod, mounted on fixed brackets on the base of the machine, and carrying stops B, which may be adjusted to any desired position to throw out the feed mechanism in the carriage of the lathe. The left-hand support C, of this bar A, contains a sleeve in which the bar is journaled. This sleeve has cut in its periphery a coarse thread, as indicated by the dotted lines, and is provided with a handle by which it may be rocked. A cone pointed screw, fast in support C, enters this groove. It will be seen that the rocking of handle D will thus move the sleeve axially, and will likewise shift the axial position of bar A and the stops B, which are mounted on it. To the left end of bar A is clamped arm E, carrying index finger F.

The operation of this device is as follows: The first piece of work of a lot having been placed on the centers, ready for turning, arm E is swung up to the work, and handle D is rocked until the end of finger F just touches the end of the work. E is then swung back again with D remaining in place. Bar A has now been set to a position depending upon the position of the end of the stock being turned; stops B next are set to give the required shoulder distances as meas-

ured from that end. If the next piece put in the machine is centered too deeply, *F* is swung up again opposite the end of the work, and *D* is rocked until the end of the finger again matches. This shifts *A* to the right as may be required to give the same dimensions as before, measured from the end of the new bar of stock. In the same way, for very rough work, the end of finger *F* is placed a trifle inside the



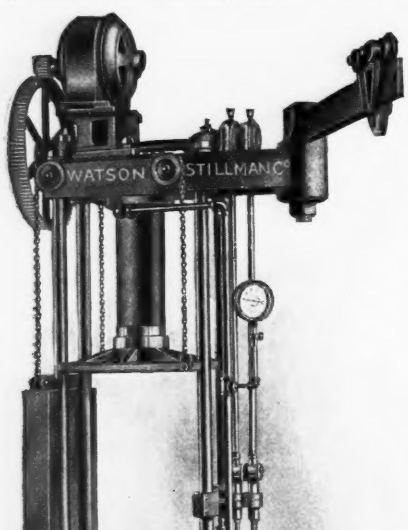
Compensating Automatic Feed Stop for Lathe

position where the end of the stock will just clean off in machining. In second operation work, finger *F* is similarly set to agree with the position of the shoulder from which it is desired to take measurements.

The operation of this stop is practically instantaneous, and adds greatly to the accuracy and convenience of the machine.

WATSON-STILLMAN REVERSED CYLINDER PRESS

A recent addition to the line of presses made by the Watson-Stillman Co., 50 Church St., New York City, is shown in the accompanying engraving. This is a reversed cylinder forcing press especially adapted for pressing on bearings and for miscellaneous shop work. As will be seen from the illustration, a crane bracket and beam, extending from one end, enables the operator to swing a heavy piece of work onto bracket shelves extending out from each side of the bottom platen. These shelves, 30 inches long by 12 inches wide, are detachable, can be lifted off, on jobs where they would be in the way, and are sufficiently strong to support any work that will go into the machine. They will be appreciated by those who have had to push castings or parts into place on the ordinary small platen.



A Press for General Shop Use in Pressing on Bearings, etc.

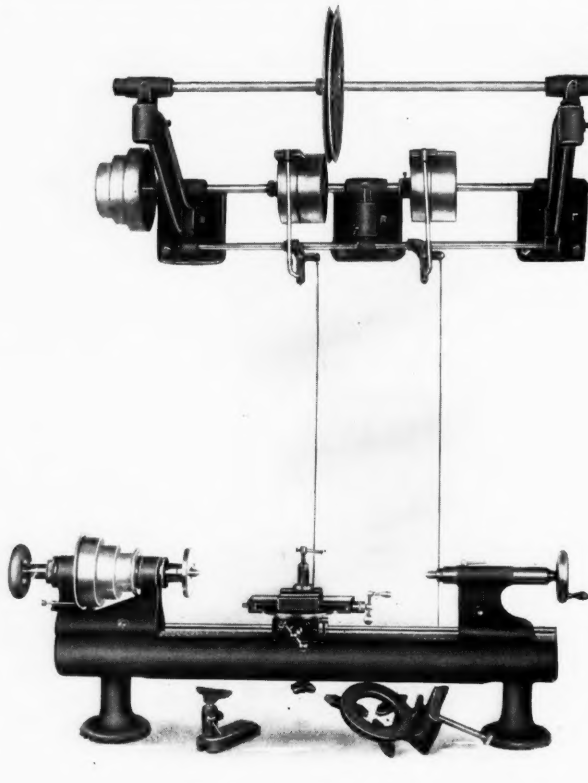
The motor, mounted upon pedestals on top of the press, drives the pump shaft through single gearing. A hand or belted drive is furnished if desired instead of the motor. On the other end of the pump shaft are two eccentrics, each driving one of the pistons of a ¾-inch by 2-inch twin pump, for which the pedestal legs act as reservoirs.

The operating valve is of the single screw stem type, and connected to release the pressure from the work when opened, and start the ram down when closed. It will not retain the pressure unless the motor is stopped or the liquid driven through the safety valve. Other types of valves may be substituted to meet special conditions. A gage is furnished to read in tons or pounds per square inch, as desired.

ROCKFORD MACHINE & SHUTTLE CO.'S PRECISION BENCH LATHE

We illustrate herewith a precision bench lathe made by the Rockford Machine & Shuttle Co., of Rockford, Ill. It is designed for small tool work, jigs, etc., or wherever accurate lathe operations are required, though it is well adapted for the finer grades of manufacturing purposes as well.

The collet has capacity for stock up to ½ inch in diameter. The lathe swings 7 inches over the bed and 4½ inches over the slide rest, and takes 16 inches between the centers.



Rockford Precision Lathe, with Wall Countershaft

A carefully designed thrust bearing is provided. The head and tail centers are ground to No. 1 Morse taper, and the rear end of the spindle is fitted to the standard size for indexing plates. The cone pulley flange is provided with two rows of index holes. The counter-shaft shown is intended to be screwed to the wall. It is provided, as may be seen, with a second shaft for driving grinding and other attachments.

STANDARD DESIGN FOR NEWTON HORIZONTAL MILLING MACHINE

The Newton Machine Tool Works, Inc., of Philadelphia, Pa., has persistently re-designed its line of horizontal milling machines, to keep pace with the capabilities of modern, inserted tooth, high-speed cutters. The changes that have been made have related mostly to the general stiffness of the machine, and to the power of the driving mechanism. It has been found that the rate of removal of metal is about 1¼ cubic inch per minute per H.P., the volume removed being proportionate to the size of the machine. This high rate of removal results in cuts so rapid, that the time of setting the work and adjusting the cutters has become the important factor on most work, rather than the time required on the cut itself. For this reason the builders have found it advisable to redesign the mechanism of their horizontal milling machines from the standpoint of convenience and rapidity of handling.

The machine shown in Figs. 1 and 2 has the controlling levers all mounted within convenient range of the operator, so that any movement except the clamping of the rail can be

obtained instantly. This latter adjustment offers no difficulties, however, since the use of roller thrust bearings at the top and bottom of the elevating screws permits the rail gibs to be tightened to a stiff running fit, and be so used for heavy cuts. Lever *A*, shown attached to the rock-shaft at the bottom

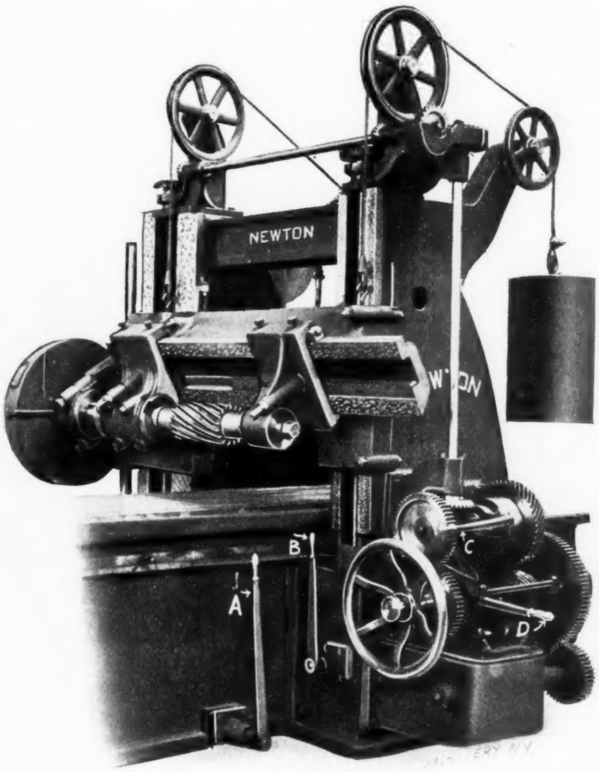


Fig. 1. The Operating Side of the Newton Standard Horizontal Miller

of the bed in Fig. 1, passes through to the opposite side as shown in Fig. 2, and is there connected with a bevel gear reversing clutch by means of which all the feeds and fast traverse movements are stopped, started and reversed. Lever *B* operates the table locking mechanism. Lever *C* operates

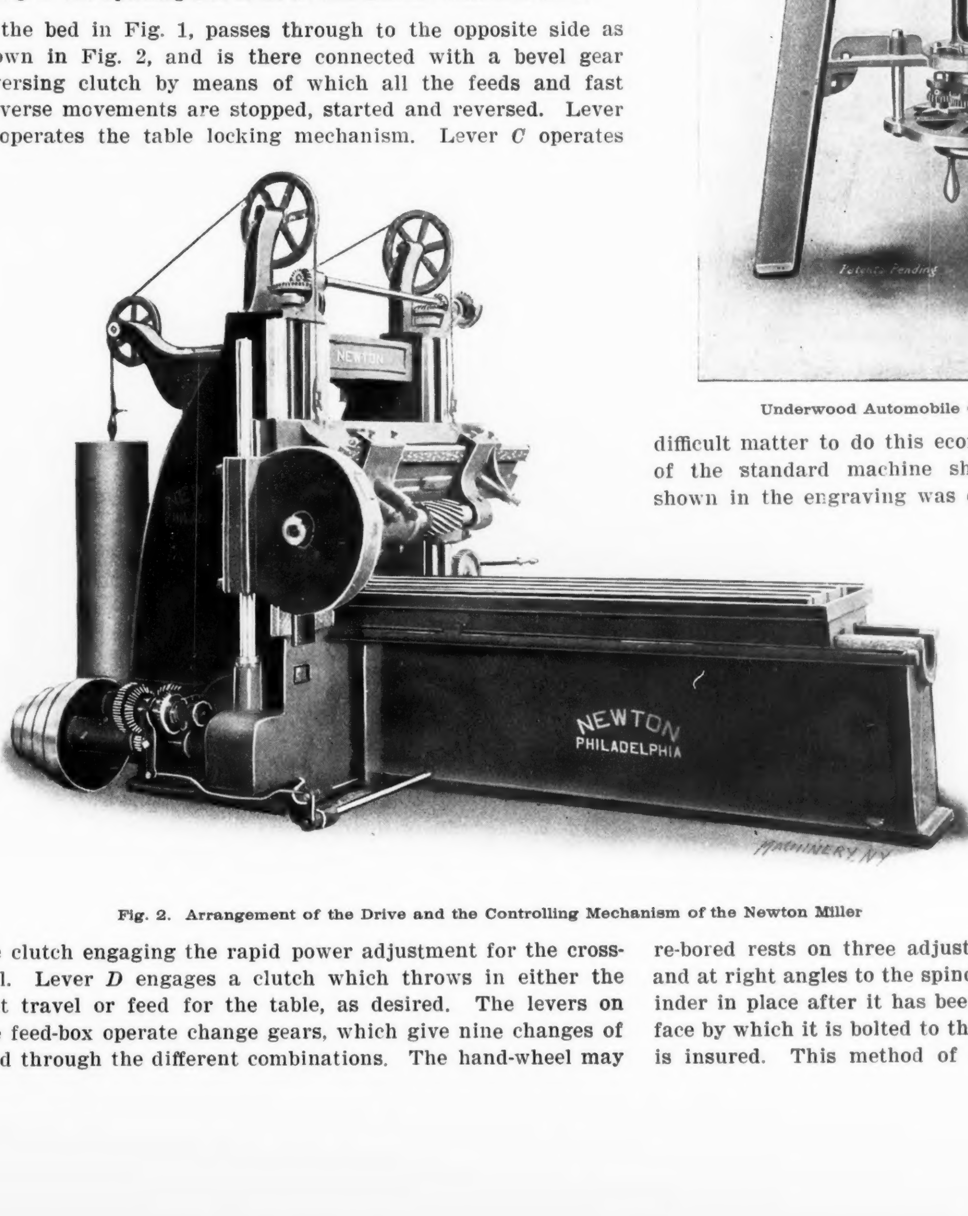


Fig. 2. Arrangement of the Drive and the Controlling Mechanism of the Newton Miller

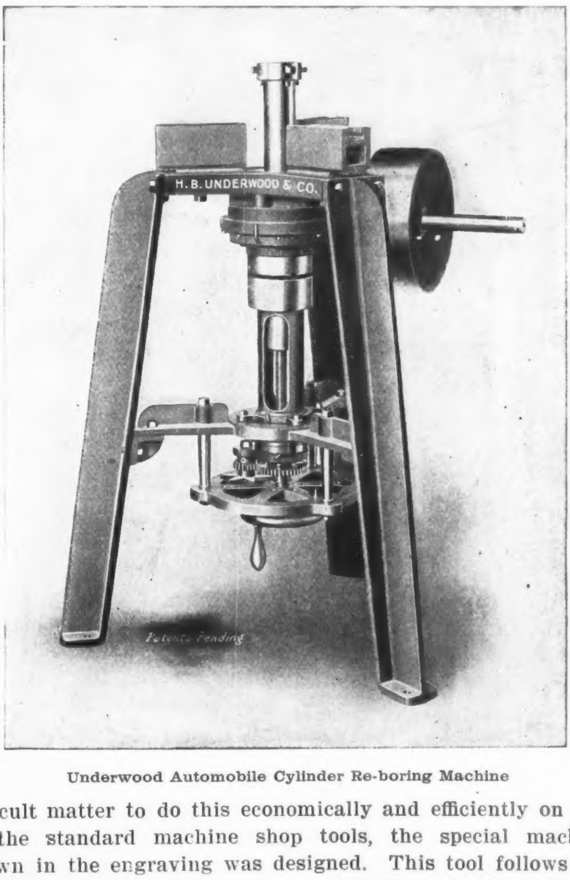
the clutch engaging the rapid power adjustment for the cross-rail. Lever *D* engages a clutch which throws in either the fast travel or feed for the table, as desired. The levers on the feed-box operate change gears, which give nine changes of feed through the different combinations. The hand-wheel may be slipped forward or back on its shaft to give hand vertical adjustment to the rail or to the table as required.

It will be seen that the operator has all the required controlling levers within easy reach of his working position.

This line of machines is complete in all sizes from the smallest (having a table 14 inches wide with 20 inches between the uprights) to the largest, having a table 60 inches wide and 70 inches between the uprights. On the machine illustrated, the makers have been able, in their own shop, on cast iron brackets, to take cuts 9 inches wide, 5/16 inch deep and 15 inches long, in one and one-half minute. Another cut which was taken was 11¼ inches wide and 3/16 inch deep with a table feed of 11½ inches per minute. The machine here shown will be supplied with either a 15 or a 20-horse-power motor, according to the work to be done. The average removal of metal is 1¼ cubic inch per minute.

UNDERWOOD AUTOMOBILE CYLINDER RE-BORING MACHINE

H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa., in the regular run of shop work has been frequently called upon to re-bore automobile cylinders. Finding it a



Underwood Automobile Cylinder Re-boring Machine

difficult matter to do this economically and efficiently on any of the standard machine shop tools, the special machine shown in the engraving was designed. This tool follows the general mechanism of the regular portable cylinder boring machine made by the builders. It is provided, in addition, with such changes in mechanism and such arrangements for mounting and holding the work, as suit the special operation of re-boring automobile cylinders.

The tool operates in a vertical position, and thus requires but little space. The boring mechanism is supported on a stout tripod as shown. The cylinder to be re-bored rests on three adjustable sliding blocks, planed true and at right angles to the spindle. Suitable clamps hold the cylinder in place after it has been centered; since it rests on the face by which it is bolted to the engine base, accurate alignment is insured. This method of holding applies equally well to

single and multi-cylinder castings, either of which styles are held without distortion. As the work is done in a vertical position, the chips fall out without clogging the cutters or interfering with the work.

The driving pulley shaft is connected with the cutter spindle by worm-gearing. The spindle or boring bar has about 15 inches travel, with a variable automatic feed operated by a star wheel engaging one or more knockers, as required. A special adjustable head is mounted on the spindle for centering the cylinder. After centering, this is removed, and the cutting tool substituted. The cutter head carries four tools which may be adjusted simultaneously to the depth of the cut by screwing down a taper seat in the center of the head. A 1-horse-power motor is sufficient to drive the machine.

This tool is also capable of boring as well as re-boring, and several of them may be set to work in a space which one large machine tool would occupy. The tool is easy to operate and does good work. Only one cut is required, and this may be taken in a remarkably short time.

HYATT HIGH-DUTY ROLLER BEARING

The roller bearing made by the Hyatt Roller Bearing Co., of Newark, N. J., is well-known to mechanics and engineers. It employs a flexible roller, which is formed of helical coils of steel, having a rectangular section. These rollers are confined in a cage which locates them properly between an inner and outer hardened shell, of which the former is made fast to the shaft and the latter to the bearing. For hardened shafts the inner bushing is omitted. In the high duty bearings here described, this inner bushing is omitted only for hardened, heat-treated shafts and rolls or coils.

This high duty type of the Hyatt roller bearing has been designed to meet conditions of service which can not be met with the commercial type. To make this increase in capacity, the carbon steel parts of the commercial type have been replaced with alloy steel, properly heat treated; also as explained above, hardened and ground inner and outer surfaces have been provided for the bearing of the rollers. The increase of capacity of the bearing thus obtained may be employed either in getting the same capacity in a smaller space than in the original form, or in getting an increased capacity in the same space. This bearing is particularly adaptable for automobile transmissions, rear axles, and other applications where the duty required of the bushing is great, while the space available for it is limited.

Hyatt High-duty Roller Bearing

Two designs are made, one of them narrower than the standard to meet the first conditions mentioned, and the other considerably wider for the heaviest service. The light series is made for shafts from ¾ to 2¾ inches in diameter, and for safe loads of from 460 to 3,030 pounds; the corresponding sizes for the heavy series have a capacity of from 1,200 to 6,890 pounds. The length of the smallest size is 2 inches over the bearing, while that of the largest is 3½. These loads give the amount of radial load that a bearing can be subjected to under a maximum speed of 1,000 revolutions per minute. The flexible nature of the roller permits the safe absorption of a reasonable amount of shock. The loads given are the results of actual tests by the mechanical inspection department of the makers, who stand always ready to assist customers in every way in the proper choice of bearings and in their proper installation.

* * *

Switzerland imports machinery to the value of about $10,000,000 yearly. Seventy-six per cent of the machinery imported is of German manufacture.

NEW MACHINERY AND TOOLS NOTES

BRAZING COMPOUND: Universal Fluxine Co., Urbana, O. This compound may be used for fusing together cast iron and other metals. It is adapted also to the brazing of high-speed steel cutters to soft steel bodies.

NAME PLATE MACHINE: Roovers Mfg. Co., Brooklyn, N. Y. This instrument is adapted to the making of embossed letters for use on patterns, machine tools, in stock rooms, etc., and for general use in numbering and classification about manufacturing plants.

ROLLER THRUST BEARING: Reeves Pulley Co., Columbus, O. This bearing was developed by the makers to fill the requirements for their variable speed transmission. It is carefully machined, and provided with thrust rollers of large diameter, held in the position required for proper action.

WATER-COOLED ROLLING MILL: Atlas Machine Co., Waterbury, Conn. This is a rolling mill for small, accurate work; it is provided with a water circulation through the rolls for carrying off the heat generated by the work performed on the metal. The rolls are 6 inches in diameter by 2½ inches face.

192-INCH PLATE SHEAR: United Engineering & Foundry Co., Pittsburg, Pa. A heavy plate shear of the guillotine type, with a capacity for shearing ⅝-inch plate 192 inches wide. The crank-shaft is supported by four bearings on a heavy truss connecting the tops of the housings. A cam-operated plate holder is provided.

COMBINATION SQUARE: W. F. Dissell, 9700 Gibson Ave., Cincinnati, O. This combination square consists of two steel rules, provided with suitable surfaces and clamps for engaging each other firmly in the various positions required for a tool of this kind. It may be set up for use as a depth gage, try square, hook rule, T square, vernier caliper, etc.

GEARED-DRIVE 20-INCH SHAPER: Mark Flather Planer Co., Nashua, N. H. This firm has recently added to its line a 20-inch gear-driven shaper made on practically the same lines as the 16-inch shaper described in the November, 1907, issue of MACHINERY. The design avoids the use of the cone pulley, and is particularly adapted to direct connection with a constant-speed motor.

PORTABLE DRILL: Coates Clipper Mfg. Co., Worcester, Mass. This portable drill is intended to be driven by the Coates flexible shaft from any convenient motor power, preferably from a portable motor. It is in the form of the ordinary breast drill. The breast-plate, however, may be removed, and the tool used with the regulation "old man."

"CITO" CUT METER. Schuchardt & Schutte, 90 West St., New York City. This is a development of the makers tachometer, arranged for giving direct readings in linear velocity. A friction wheel is provided which is placed against the surface whose speed is to be measured. The readings are made from a dial graduated in meters per minute, or feet per minute, as required.

COMBINED PUNCH AND SHEAR: Jannell Machine Co., Rumford, Me. This is a small tool, standing a little over 3 feet high. It will punch ⅝-inch holes in ⅜-inch iron, and has sufficient gap capacity and driving power to shear ⅝-inch stock 6 inches wide. The tool has a distinctive appearance, being mounted on a heavy base with all the gearing and other mechanism below the dies.

HEAVY FIVE-SPINDLE MILLING MACHINE: Niles-Bement-Pond Co., 111 Broadway, New York City. This is a heavy milling machine provided with two facing heads on the cross-rail, a side facing head on the front of each housing and a horizontal slab milling spindle. The vertical spindles are both counterweighted. The table has a working surface 14 feet long, and the clear width between the uprights is 38½ inches.

SHOP TRANSIT: H. W. Brown, 63 Canal St., Waterbury, Conn. This tool is a modification of the engineer's transit, omitting every adjustment and piece of mechanism that is not required for shop use. It will be found useful in connection with the modern practice of laying out large work by sighting through the telescope, as well as for running line shafts, setting foundations, etc.

AUTOMOBILE CYLINDER BORING MACHINE: Newton Machine Tool Works, Inc., Philadelphia, Pa. This is a double-head boring machine with spindles driven by worm-gearing, so arranged that the center distances may be adjusted without disturbing the drive. The machine is arranged for either open or closed cylinders, as may be required. Four changes of feed are provided.

PORTABLE BORING MACHINE: Beaman & Smith Co., Providence, R. I. This machine has unusual capacity for a portable tool. It is of the type in which the column, carrying a vertical traveling spindle head, is adjustably mounted on ways on a horizontal base. It is provided with all the movements and conveniences of the ordinary stationary machine, though intended for portable use. It weighs about 15 tons.

STEAM HAMMER HAVING ANVIL SOLID WITH THE FRAME: Niles-Bement-Pond Co., 111 Broadway, New York City. The anvil is mounted directly on the base. The side housings are lipped over bearings on the top of the base, and are held to it by bolts provided with heavy springs to allow a slight vertical movement from the rebound of the blow. This is an 8,000-pound hammer of the double housing type.

SPECIAL LATHE FOR BILLET TURNING: Pacific Iron Works, Bridgeport, Conn. This is a lathe designed especially for turning billets of copper, brass or other alloys for the purpose of cleaning off the scale and other imperfections before putting them through the rolls. This operation also serves to reveal flaws which might otherwise remain hidden. Special holding devices for supporting the billets are provided. The machine weighs about 7,000 pounds.

ANGLE DRIVE: Max Ams Machine Co., Mt. Vernon, N. Y. This drive is adapted to the transmission of power through shafting set at right angles. It consists of two short pulley shafts connected by sprockets and a special chain running over sprocket idlers. The chain is so constructed that it will bend and run over sprockets in all four directions. This device is built to transmit various amounts of power as required.

DOUBLE-END LATHE TOOL: Taylor Mfg. Co., Hartford, Conn. This tool-holder has a provision for clamping a round shank blade at either end, one of the blades being held horizontally and the other at an angle. The blades may be easily ground as turning tools, parting tools, threading tools, etc. The round shank arrangement gives the edge an adjustable cutting angle, and permits tipping the threading tool to agree with the angle of the thread.

PRESS FOR SHALLOW DRAWING AND FORMING IN HEAVY PLATE: Ferracute Machine Co., Bridgeton, N. J. This press, being designed for large work in heavy metal, has been given the form of the coining press made by the same builders. The lower bed or "ram" is operated by a toggle joint mechanism. The blank holder in the upper member is supported by heavy springs, grouped in a casing at the top of the frame. The ram is capable of exerting a maximum pressure of 450 tons.

MOTOR-DRIVEN VERTICAL SPINDLE MILLING MACHINE: Newton Machine Tool Works, Inc., Philadelphia, Pa. This vertical spindle milling machine is of large capacity and heavily built. Work 10 inches in height can be taken between the table and the end of the spindle. The distance from the center of the spindle to the face of the column is 33 inches. The length of the in-and-out feed and the length of the cross-feed are also of the same dimension.

HIGH-SPEED STEAM-HYDRAULIC FLANGING PRESS: United Engineering & Foundry Co., Pittsburg, Pa. This is a form of rapid action, horizontal press, built on Davy patents, whose principles were discussed in an article entitled "Rapid Action Hydraulic Forging Press," in the May, 1907, issue of MACHINERY. The makers have acquired the right to this important machine for the United States. This press is intended to take the place of the steam hammer in ordinary machine forging, doing the work as quickly and more effectively.

SLAB MILLER WITH AUXILIARY VERTICAL AND HORIZONTAL SPINDLE: Ingersoll Milling Machine Co., Rockford, Ill. This tool is one of the builders' regular slab or horizontal spindle milling machines, provided with an auxiliary head, carrying two spindles at right angles to each other, on either of which milling cutters may be mounted. The attachment is particularly adapted to face milling in either the horizontal or vertical plane, simultaneously with the use of a regular milling cutter for the main arbor.

INDEPENDENT CHUCK WITH DIFFERENTIAL SCREW MECHANISM: Carter Chuck Co., St. Louis, Mo. This is an independent chuck, with a neatly designed differential screw mechanism for setting down the jaws on the work. This gives, of course, a much greater gripping power than can be obtained with an ordinary screw. The construction is such that most of the wear comes on an easily renewed member, making repairs simple and inexpensive. The matter of durability, however, has been carefully considered in the design of the tool.

CRANK-SHAFT GRINDING MACHINE: Tindel-Morris Co., Eddystone, Pa. This is a grinding machine specially designed for multiple throw crank-shafts. These shafts are driven from each end by geared head-stocks, provided with face plates which hold the work without requiring special fixtures of any kind. Counter-balances are provided on each face-plate to insure steady running. Suitable back-rests, truing stand, etc., are furnished, so that the grinding is effected as conveniently as for ordinary cylindrical work.

ARMINGTON ELECTRIC HOIST: Armington Electric Hoist Co., Wickliffe, O. These hoists are made in various styles, either for single point suspension, with plain or geared trolley, or in the trolley form with both power hoist and travel. They are made in sizes from 1 to 10 ton capacity, with a standard hoisting speed of from 1 to 12 feet per minute. An improved brake mechanism is employed; it is of the coil type, and of practically one-piece construction. The mechanism is very compact, though accessible. Careful attention has been given to lubrication.

NELSON COMBINED RATCHET WRENCH AND DRILL: L. H. Brown Mfg. Co., Carlinville, Ill. This reversible ratchet drill is provided with adjustable chuck jaws, which may be used for holding nuts, bolt heads, etc., as well as for holding drills. By removing the feed-screw, a free hole is left through the center of the tool, so that it may be slipped over a long threaded bolt. The ratchet mechanism is entirely enclosed, making the tool more durable than with the ordinary open construction. The head room is unusually short, adapting it to use in confined places.

DRAFTSMEN'S PROTRACTOR: L. S. Starrett Co., Athol, Mass. This is a protractor intended especially for use in the drafting-room. It is made of sheet steel, nickel-plated and is graduated in degrees to read from either left or right. The vernier provided gives accurate readings to within 5 minutes. The straight edges of the protractor are graduated in inches and 16ths, the adjustable edge being graduated to 6 inches in length. Angles can be reversed without resetting by simply turning the instrument 90 degrees around on the T square or straight edge.

TOOL-HOLDER FOR TURNING AND THREADING: G. R. Lang Co., Meadville, Pa. The idea incorporated in the locomotive and car wheel tire turning tool made by this firm, and mentioned in a note in the December, 1908, issue of MACHINERY, has been applied to a general tool-holder for turning, threading, etc. The threading blades and the smaller turning blades are made from triangular drawn stock. Larger tools are milled from stock to fit the dovetail in the holder. The lock-bolt in the latter supports the blade against a solid abutment, and at the same time clamps it tightly in place by frictional means.

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In a paper read before the *Société de Ingenieurs Civils de France*, it was stated that in the Messina earthquake, reinforced concrete proved itself to be the safest building material for regions thus afflicted. One typical example is cited of a house now standing in the center of a section where all the other buildings were reduced to fragments. This house sheltered a family the members of which are now the sole survivors within a large adjacent area. The one million-gallon reinforced concrete reservoir supplying the city with water suffered no damage.

PRESENTATION OF THE JOHN FRITZ MEDAL TO CHARLES T. PORTER

The National Engineering Societies, comprising the American Society of Civil Engineers, The American Institute of Mining Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, conferred the John Fritz medal for 1908 on Mr. Charles T. Porter for his work in advancing steam engineering and his improvements in engine construction. The medal was presented in the presence of a distinguished company on the evening of April 13th, in the auditorium of the Engineering Societies' building at 29 West 39th St., New York.

The John Fritz medal was established by the professional associates and friends of John Fritz, of Bethlehem, Pa., on August 21, 1902, his eightieth birthday, to perpetuate the memory of his achievements in industrial progress. (See MACHINERY, September, 1902.) The awards are made annually by a board of sixteen, appointed or chosen in equal numbers from the membership of the four societies named. The awards up to date have been as follows:

First award, January 20, 1905, to Lord Kelvin for his work in cable telegraphy and other scientific attainments.

Second award, January 19, 1906, to George Westinghouse for the invention and development of the air brake.

Third award, January 18, 1907, to Alexander Graham Bell for the invention and introduction of the telephone.

Fourth award, January 17, 1908, to Thomas Alva Edison for the invention of the duplex and quadruplex telegraph, the phonograph, the incandescent lamp system of electric lighting, etc.

Fifth award, January 16, 1909, to Charles T. Porter for his work in advancing the knowledge of steam engineering and in improvements in engine construction.

Mr. Henry R. Towne, chairman of the board of award, presided at the meeting, and Dean W. F. M. Goss, of the University of Illinois, read a paper entitled "The Debt of Modern Industrial Civilization to the Steam Engine as a Source of Power." After the presentation of the medal to Mr. Porter letters of salutation were read from societies and prominent engineers in the United States and Europe, and then followed a paper by Prof. F. R. Hutton, of Columbia University and honorary secretary of the A. S. M. E., "The Debt of the Modern Steam Engine to Charles T. Porter." Robert W. Hunt followed with "The Debt of the Era of Steel to the High-Speed Steam Engine," and Frank J. Sprague concluded with "The Debt of the Era of Electricity to the High-Speed Steam Engine."

Professor Hutton spoke in detail of the pioneer work of Mr. Porter, and gave him credit for first seeing the great possibilities of the high-speed engine. In analyzing the debt we owe to the work of Mr. Porter, stress was laid on the following:

"First, the reciprocating engine owes to him the first vision of the advantages that come from making the crank-shaft turn at a high number of revolutions whereby the weight of the motor per horse-power is reduced; and second, for raising the standard of mechanical construction because of the necessity of such in the high-speed engine. We owe to Mr. Porter many engineering details which are commonplaces of modern practice. He created a condenser air pump that was directly connected to the engine and capable of running at high speed, and a highly sensitive governor in two forms."

Among those present on the rostrum were: James C. Brooks, Charles L. Clarke, W. F. M. Goss, C. W. Hunt, F. R. Hutton, George W. Melville, Alfred Noble, C. A. Parsons (England), W. H. Pegram, Charles T. Porter, Charles B. Richards, Henry R. Towne, Jesse M. Smith, E. G. Spilsbury, Frank J. Sprague, Ambrose Swasey, John E. Sweet, E. Swenson, G. G. Ward, S. S. Wheeler.

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A record in long-distance telegraphy has been achieved by the Indo-European Telegraph Co., which has succeeded in transmitting messages direct from London to Calcutta, a distance of 7,000 miles, with no intermediate re-transmissions. A speed of forty words a minute was maintained.

NEW STEAM-ENGINE VALVE MECHANISM

On April 6 the Rothchild Engine Company, 102 Center Street, New York, gave a public demonstration of a new and novel form of valve mechanism which the company expects to apply to both stationary engines and locomotives. The engine which has been built for the purpose of trying out the new valve has four cylinders which are cast integrally in pairs. The steam chest for each set of cylinders is located at the top and contains a single valve which is in the form of a cylindrical bushing. These valves are connected by a shaft which is rotated from the main shaft below, by a chain, and sprockets so proportioned that the crank-shaft makes three revolutions while the valves are making one. Three steam ports, 120 degrees apart, are cut into the valve for each cylinder. Each set of three ports is in line with a larger main port opening into the cylinder, and as the valve turns one-third of a revolution, while the crank-shaft makes a complete turn, obviously, one port will be at the point of admission at the beginning of each stroke. The live steam which is within the cylindrical valve would be admitted to the cylinder while the port in the valve was passing the larger main port were it not for a half-round cut-off valve which fits inside of the cylindrical valve. This cut-off valve closes the port and cuts off the steam at a point depending upon its angular position which is varied by the movement of a lever. The point of release occurs when the port through which steam was admitted opens into the exhaust port which is located in the lower side of the cut-off valve. By changing the position of this valve so that its opposite edge controls the point of cut-off, the reversal of the engine is effected.

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The Queensboro, or Blackwell's Island bridge, joining Manhattan Island and Queens County, New York, was opened to traffic March 30. This bridge is of the cantilever type and is one of the three great cantilever structures in the world, completed or in construction, the other two being the Firth of Forth bridge and the Quebec bridge, one section of which fell in process of construction last year. The Queensboro bridge is 8,600 feet long, including the approaches. The bridge proper is 3,746 feet long, made up as follows: Anchor span, 460 feet; channel span, 1,182 feet; island span across Blackwells Island, 632 feet; span over the east channel of the river, 984 feet; and anchor span on the Long Island shore, 459 feet. The approaches are 4,854 feet. The roadway is 135 feet above mean high water mark and the towers are 185 feet above the bottom chord. The height of the trusses of the island span is 118 feet. This is the heaviest part of the bridge, weighing 10,400 tons or 16½ tons to the linear foot. The steel superstructure was furnished by the Pennsylvania Steel Co. and weighs 52,000 tons. The width between the railings of the lower floor is 86 feet and of the upper floor 67. The total cost of the bridge is about $20,000,000. Ground was broken for the bridge in 1893, but active work was not begun until January, 1901. Following the fall of the Quebec bridge, an investigation was made of the plans for the Queensboro structure, and it was deemed unadvisable to subject it to the load for which it was originally designed. It was designed to carry four elevated railway tracks, but only two will be laid. Provision is made for four trolley tracks and one 34-foot roadway on the lower deck and two rapid transit tracks and two 14-foot walks on the upper deck.

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PERSONAL

Percy Reston has been promoted to the position of chief draftsman in the office of the Cincinnati Planer Co.

John W. Freeman has been appointed manager of the Sprague Electric Co.'s Pittsburg office to succeed Mr. F. W. Parry, who recently resigned.

James Hartness, president of the Jones & Lamson Machine Tool Co., Springfield, Vt., sailed for Europe April 14 on the steamer *Mauretania*.

E. E. Brosius, Alliance, Ohio, has been made sales manager of the Pawling-Harnischfeger Co., Milwaukee, Wis., builders of traveling cranes.

H. W. Bridge is now president of the Buckeye Equipment Co., Cincinnati, O., having succeeded J. S. Nowotny, who retired from the company some time ago.

At the last meeting of the directors of the firm of John Steptoe Shaper Co., Cincinnati, Ohio, G. K. Atkinson, superintendent, was elected secretary-treasurer.

H. M. Wood, formerly with the Niles-Bement-Pond Co., has joined the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, to act as publicity and advertising manager.

J. B. Baker of the Safety Emery Wheel Co., Springfield, Ohio, sailed April 1 for a two months' business trip to England, Germany, Holland, Norway and Sweden.

H. L. Clark, formerly superintendent of the Dominion Coal Co., Glace, Cape Breton, has recently been appointed superintendent of the Chester Park shops of the Cincinnati Traction Co.

M. E. Dewstoe, First National Bank Building, Birmingham, Ala., has been appointed selling agent of the Bullard Machine Tool Co., Bridgeport, Conn., in the Alabama and Tennessee territory.

W. Robertson has severed his connection with the Robertson Mfg. Co., Buffalo, N. Y., and is now with the Robertson Drill & Tool Co., manufacturers of a line of power hack saws and drill presses.

H. W. Kreuzburg, president of the Champion Tool Works Co., Cincinnati, O., recently returned from a business trip which included San Francisco, Denver, Salt Lake City and other large cities in the West.

Philip Fosdick, president, and R. K. Le Blond, vice-president of the Cincinnati Chuck Co. Cincinnati, Ohio, are in Europe on a business-pleasure trip. They expect to return to this country about May 1.

John R. Kempf, secretary and treasurer of the Star Corundum Wheel Co., Detroit, Mich., sailed for Europe April 16 on the steamer *St. Paul.* to make an extensive business tour of England and the Continent.

C. G. Hafley, formerly advertising manager for the Buffalo Forge Co., Buffalo, N. Y., and later with the Keuffel & Esser Co., is now with the Vechten-Waring Co., 92 John St., New York, acting as assistant in the advertising service department.

W. H. Smead, mechanical engineer, has moved his office from Greenboro, N. C., to 207 Prudential Building, Atlanta, Georgia. Mr. Smead will continue his general engineering business, making a specialty of designing power and heating plants.

Frank Wells Hall has been appointed manager of the Philadelphia office of the Sprague Electric Co., New York. Mr. Hall formerly was connected with Sprague Electric Co. both in the New York and Chicago offices in an engineering and sales capacity.

F. O. Hoagland, who for twelve years past has been connected with the Pratt & Whitney Co., Hartford, Conn., the last eight years of which as department foreman, has been made chief mechanical engineer with the Remington Arms Co., Ilion, N. Y.

W. S. Rogers, president of the Bantam Anti-Friction Company, Bantam, Conn., sailed for Germany April 29, on the invitation of several German makers of balls and ball bearings, to make close connections for the handling of their goods in this country.

D. B. Clark, master mechanic of the Chester Park Shops of the Cincinnati Traction Co., has been appointed master mechanic of the Columbus shops of the Ohio Electric Railway Co. Mr. Clark will continue to hold his position as master mechanic of the Chester Park shops.

Hermann Hill, 437 Columbus Ave., Boston, Mass., has invented machinery for the manufacture of expanded metals and will organize a company called the Steel Fire Proofing Co., for the manufacture of expanded metals for all classes of service. The factory will be located in Pittsburgh, Pa. His temporary shop is at 82 Purchase St., Boston, Mass.

George Taylor, for the past three years connected with the testing and construction department of the General Electric Co., of Schenectady, N. Y., lately resigned to become a partner in the Taylor Machinery Co., 8 Oliver St., Boston, Mass., a concern recently organized by Thomas I. Taylor, as noted in the March number of MACHINERY.

P. V. Vernon, chief designer of Alfred Herbert, Ltd., machine tool builder, Coventry, England, has sent a communication to the American Society of Mechanical Engineers, of which he is a member, proposing that the British Institution of Mechanical Engineers and the American Society of Mechanical Engineers cooperate to secure the adoption of a standard for involute gearing.

P. E. Montanus, president of the Springfield Machine Tool Co., Springfield, Ohio, returned from a two months' business trip in Europe, March 27. Mr. Montanus reports that the outlook for the sale of standard American machine tools in foreign markets is not promising and that foreign manufacturers are rapidly developing imitations of American machines, which are sold at lower prices than the American tools.

Frank P. Peters has been promoted from the position of general foreman of the Sodemann Heat & Power Co., St. Louis, Mo., to that of superintendent of the entire factory. Mr. Peters went from the United States Heater Co., Detroit, Mich., in January, 1908, to take charge of the machine department, and was soon promoted to general foreman. He has had about ten years' experience in the manufacture of radiators and heating apparatus, and is a practical machinist.

Edwin C. Thurston, who has been with the Gould & Eberhardt Co. for the past four years, in their machine designing department, and who was formerly with the Brown & Sharpe Mfg. Co. for a period of over ten years, having had experience and charge of work in the various machine tool and sewing machine departments, has associated himself with Mr. J. C. Blair, expert tool maker, machine builder and manufacturer of metal specialties. Messrs. Thurston and Blair will take up special small machinery and tool designing and building, metal specialties, model and experimental work, pattern making, drawings, tracings, blue-printing, etc., and also developing and perfecting ideas for inventors. They are located at 78 Clinton St., Newark, N. J.

James R. Anderson, sales manager of the Lunkenheimer Co., Cincinnati, Ohio, recently returned from a business trip through South America. In an interview he laid much stress on the bad results on American commerce caused by poor packing of goods. He said that American manufacturers, including those in all lines, do not pack their goods strong enough for rough handling. As a consequence, packages are frequently broken and goods of all kinds are lost or damaged in transit. Another serious fault is that American manufacturers do not cater to the size, kind, quality and weights of packages that South Americans want. It appears that it will be necessary for American manufacturers who desire to develop a South American trade, to send a trustworthy representative who will spend some time in making the acquaintance and learning the peculiarities of the inhabitants. There are many prejudices to overcome and ideas to be conformed to. The custom house regulations of various countries are complex and a great deal of attention must be given to meeting these regulations to avoid loss and trouble.

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OBITUARIES

G. Charles Connor died March 27 of blood poisoning following an operation for intestinal abscess. Mr. Connor was manager of the Philadelphia office of the Sprague Electric Co., which position he had held since February, 1903. He leaves a widow and son.

Nathan P. Towne, chief engineer of the Cramp Ship Building Co., Philadelphia, Pa., and formerly an engineer of the United States Navy, died at his home in Philadelphia, April 23. Since 1893 Mr. Towne designed and superintended the construction of the engines of nearly all the battleships, cruisers and vessels built at Cramp's.

John Hall, a prolific inventor, died of pneumonia at St. Luke's Hospital, New York, April 20, aged eighty years. He was the inventor of the Hall car coupler, and while chief engineer of the A. Coburn Co., Philadelphia, Pa., manufacturers of thermometers, he made many improvements which greatly reduced the cost of thermometers, and made possible the cheap thermometers now in common use.

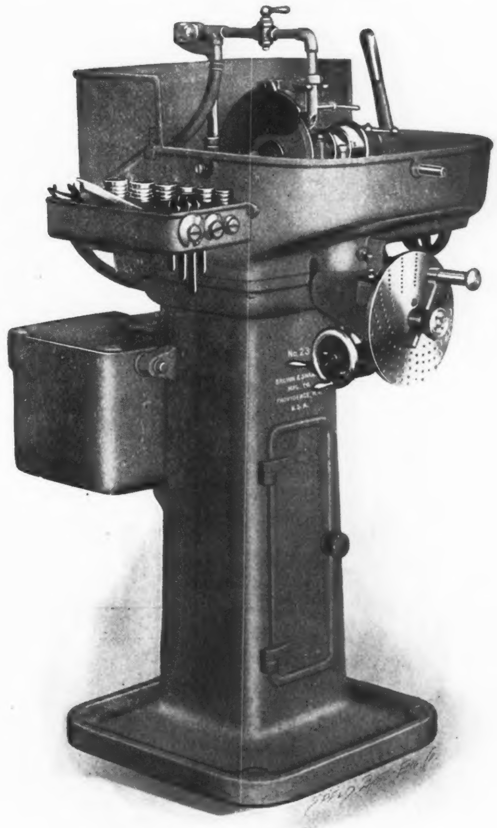
MATTHEW MORTON

Matthew Morton, president and founder of the Morton Mfg. Co., Muskegon Heights, Mich., died at his home in that city, March 10, from an attack of pneumonia, in the seventy-third year of his age. A passion for mechanics and development of new ideas and improvements in machinery characterized Mr. Morton's life, and he was actually engaged in his business pursuits up to the Saturday noon preceding his illness.

Mr. Morton was a native of Scotland. He was born in Ayrshire, May 5, 1836. His father and mother, James and Margaret Morton, moved their family to America in 1844, and settled on a farm in Armada Township, Macomb Co., Michigan. Mr. Morton lived on the farm until he attained his majority. He frequently would go to Romeo, a distance of seven miles, to market and generally spent a little time at a machine shop there in making parts for a foot lathe. These parts he took home and stored in the woodshed, and one rainy day, when they were all ready, he assembled the lathe, quite to the displeasure of his parents, who did not take kindly to mechanical pursuits, but the lathe served its purpose and helped do the repair work in the community to general satisfaction. This incident clearly shows the trend of Mr. Morton's mind in early years.

After becoming of age, Mr. Morton moved to Armada village and with his foot lathe started in business, and a year later moved to Lapeer, Mich., at that time a frontier lumber town, and engaged in the steam engine business under the name of the Lapeer Engine Works. In 1861 he constructed his first steam engine, making the patterns and molding them and melting the iron in a home-made cupola. He machined the parts and assembled the engine unassisted, and did the entire work himself. He made a reputation for building engines of

Providence, Rhode Island, U. S. A.



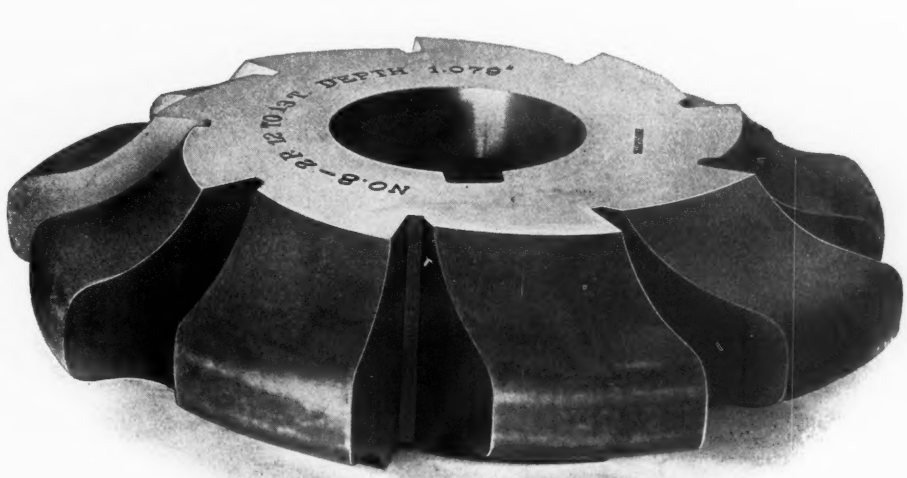
ACCURACY is a part of the machines because of their rigid construction, large index wheels, accurate indexing mechanisms, and long and wide bearing surfaces.

ACCURACY is established in the cutters because their forms are carefully laid out from original curves which are the standards of modern gearing practice.

ACCURACY in the grinding is made possible because the machines grind every cutter radially and equidistant, which is the only way the original forms of the cutters can be maintained.

By means of such a combination of B. & S. Machines and Cutters, accurately cut gears are obtained.

Write for circulars of the machines and cutter list.



Matthew Morton

very low steam consumption, and a prosperous business was established.

In 1866 he formed a co-partnership with the late William McDonald, which lasted for about five years. In 1871 he disposed of his interest in Lapeer to Mr. McDonald and moved to Romeo, where he again started the business of building engines. While in Romeo he built his first marine engine which operated with such economy and was so satisfactory that the user made him a present of $100. He also built a portable machine for boring cylinders and with it by hand bored out four locomotive cylinders in twenty hours.

From 1875 to 1878 he was engaged in building and repairing marine and stationary engines with Mr. A. H. Hamblin in St. Clair, Mich. The partners returned to Romeo where they began manufacturing agricultural machinery, but depression in business and financial reverses overtook them and Mr. Morton again started at the foot of the ladder with his foot-power lathe, and then founded the present business. He built the first successful key-seater that cut with a single tool, which proved to be constructed on the best principle for cutting key-ways. The developments of this line were such that machines were required to be built to cut key-ways up to six feet long and six inches wide.

In 1887 Mr. Morton developed the Morton portable slotter and planer, which was the first machine used in the Pittsburg district for planing the feet and windows of roll housings. The machine proved to be a valuable tool for heavy work and has since been largely sold to builders of heavy machinery in America and foreign countries. In 1891 Mr. Morton and the other members of his company moved to Muskegon Heights, a suburb of Muskegon, where in the same year the Morton Mfg. Co. was incorporated with Matthew Morton, president; A. T. Morton, vice-president; and William Rowan, secretary and treasurer, who have since been officially connected with the company. From this time on the draw-cut shaper was developed for general machine shop work, railroad work, steel foundry work, etc. The first machine built was of 26-inch stroke, from which start machines have been developed up to the traveling head planer and shaper, the largest in the world, having a stroke of seven feet. The machine stands 22 feet high and weighs 35 tons complete.

Mr. Morton was original in his ideas and constructive methods. He never looked at the catalogues of other machine tool builders to see what he should make. During his life he took out over forty patents, which nearly all have proved to be useful and valuable. He is survived by his wife, a daughter and two sons.

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SOCIETIES AND COLLEGES

Beloit College, Beloit, Wis. Sixty-second annual announcement and catalogue for 1909-10. 159 pages, 5¼ x 7⅜ inches.

University of New Mexico, Albuquerque, N. M. Bulletin of the university containing catalogue for 1908-09 and announcements. 126 pages, 5⅜ x 7½ inches.

The Massachusetts Institute of Technology, Boston, Mass., has made fuller provision for advanced study relating to the higher degrees of Master of Science, Doctor of Philosophy, and Doctor of Engineering. During the present year, graduate students were awarded $5,100 for scholarships and graduate scholarships. The library received accessions aggregating 5,463 items for the year of 1908.

The executive committee of the Museum of Safety and Sanitation, of 29 W. 39th Street, N. Y., has detailed Dr. Wm. H. Tolman, the director, for field work, and he will start May 1 on a lecturing tour. Chambers of commerce, manufacturers' associations, engineering, insurance and architectural societies, railway and other clubs, may avail themselves of this illustrated exposition of devices and methods for reducing damage suits and preserving efficiency for the cost of the lantern operator ($10) if not too far removed from the itinerary.

The National Metal Trades Association held its eleventh annual convention in the Hotel Astor, New York, April 14 and 15. Nearly 200 were registered in attendance, and the association was welcomed by Hon. Patrick H. McGowan, president of the New York Board of Aldermen. A number of valuable papers were presented and discussed. Among them was, "Profit Sharing," by R. T. Crane, Crane Co., Chicago, Ill., and N. O. Nelson, N. O. Nelson Mfg. Co., St. Louis; "The Premium System of Paying for Labor," by F. C. Blanchard, works manager, The Ashcroft Mfg. Co., Bridgeport, Conn.; "Industrial Peace," by Hon. C. P. Neill, United States Commissioner of Labor; "What the Workingman Wants from the Employer," by James Wilson, president Pattern Makers' League of North America; "Employers' Liability Insurance," the Hon. Epaphroditus Peck, of Yale University: "Industrial Training Through Apprenticeship Systems," by E. P. Bullard, Jr., of the Bullard Machine Tool Co., Bridgeport, Conn., "The Labor Question," by David Gibson, editor "Common Sense," Cleveland, Ohio. The officers elected for the coming year are: H. P. Eells, president; J. H. Schwacke, first vice-president; H. W. Hoyt, second vice-president, and William Lodge, treasurer.

The charter members of the Museum of Safety and Sanitation met on Tuesday evening, March 30 and elected the following officers: Acting president, Philip T. Dodge; vice-presidents, Charles Kirchhoff, T. C. Martin, Prof. F. R. Hutton, and R. W. Gilder; treasurer, Robert A. Franks; plan and scope committee, Prof. F. R. Hutton, William J. Moran, Dr. Thomas Darlington, H. D. Whitfield, and P. T. Dodge; director, Wm. H. Tolman. The Museum of Safety and Sanitation has its office at the United Engineering Societies' Building, 29 West 39th Street. The objects of the museum are to study and promote means and methods of safety and sanitation and the application thereof to any and all public or private occupations whatsoever, and of advancing knowledge of kindred subjects; and to that end to establish and maintain expositions, libraries and laboratories and their branches, wherein all matters, methods and means for improving the general condition of the people as to their safety and health, may be studied, tested and promoted, with a view to lessening the number of casualties and avoiding the causes of physical suffering and of premature death; and to disseminate the results of such study, researches and tests, by lectures, exhibitions and other publication.

COMING EVENTS

May 4-7.—Spring meeting at Washington, D. C., of the American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City, secretary.

May 5-7.—Joint convention of the Southern Supply and Machinery Dealers' Association and American Supply and Machinery Manufacturers' Association, Chattanooga, Tenn. Alvin M. Smith, Richmond, Va., secretary and treasurer of the Southern Supply and Machinery Dealers' Association, and F. D. Mitchell, secretary and treasurer, American Supply and Machinery Manufacturers' Association, 309 Broadway, New York.

May 12-14.—Annual meeting of the National Supply and Machinery Dealers' Association, at the Fort Pitt Hotel, Pittsburg, Pa. Secretary-Treasurer, A. T. Anderson, 41 Wade Building, Cleveland, Ohio.

May 18-20.—American Foundrymen's Association convention, Cincinnati, Ohio, Hotel Sinton, headquarters. Richard Moldenke, secretary, Watchung, N. J.

May 25-26—Spring convention of the National Machine Tool Builders' Association at Milwaukee, Wis. Plankington House, headquarters. P. E. Montanus, president of the Springfield Machine Tool Co., Springfield, Ohio, secretary.

May to November, 1910.—International Exhibition of Railway and Land Transport, Buenos Ayres, Argentine Republic, commemorating the first centennial of the Argentine Independence. The officers of the exhibition are, Alberto Schneidweind, general director of Argentine Railways, president; H. H. Loveday, general manager of Argentine Railways, and Dr. H. H. Trays, local director of Central Argentine Railways, vice-presidents; Juan Pelleschi, commissioner general; Eduardo Schlatter, secretary.

June 1.—Opening of the Alaska-Yukon-Pacific Exposition in Seattle, Washington, which is designed to call the attention of the world to the importance of Seattle as the western gate-way to the United States, and to its rapidly growing commercial importance. The exposition will include many working exhibits, among which are meat packing, watch making, jewelry, silk-making, rope-making, telephoning, printing, etc.

June 1-5.—Annual meeting of the International Railway General Foremen's Association at Chicago, Ill. E. C. Cook, Royal Insurance Building, Chicago, Ill., secretary.

June 7-19.—Cleveland Industrial Exposition, under the auspices of the Cleveland Chamber of Commerce, Cleveland, Ohio. It is estimated that 125,000 different articles are manufactured in Cleveland's 3,500 shops, and it is proposed to display to the world at this exposition the wonderful industrial facilities of the city. The products comprise steel ships, heavy machinery, hardware, twist drills, reamers, milling cutters, wire nails, bolts, nuts, vapor stoves, malleable castings, automobiles, paints and oils, etc. William G. Rose, Cleveland, Ohio, secretary.

June 9-11.—Joint convention of the Southern Hardware Jobbers' Association and the American Hardware Manufacturers' Association at Hotel Shenley, Pittsburg, Pa. F. D. Mitchell, 309 Broadway, New York, secretary and treasurer.

June 16-18.—Annual convention of Railway Master Mechanics' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 21-23.—Annual convention of the Master Car Builders' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 22-24.—National Gas and Gasoline Engine Trades Association convention, South Bend, Ind. Headquarters, Oliver Hotel. Albert Stritmatter, Cincinnati, Ohio, secretary.

September 25-October 2.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the Tribune Building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett, secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

NEW BOOKS AND PAMPHLETS

New Method of Gas Manufacture, by Henry I. Lea. Pamphlet of 16 pages, 6 x 9 inches. Paper read before the Illinois Gas Association, Chicago, Ill., March 17, 1909. Henry I. Lea, The Rookery, Chicago, Ill.

Social Engineering. By W. H. Tolman, with introduction by Andrew Carnegie. 364 pages. Published by the McGraw Publishing Co., New York. Price $2, instead of $5 as given in the review in the April number.

Annual Report (49th) of the Superintendent of Insurance of the State of New York, Part 4. Assessment or Cooperative and Fraternal Insurance. 271 pages, 6 x 9 inches. Published by the State of New York, Albany, N. Y.

A Study of Roof Trusses, by N. C. Ricker, and Lighting Country Homes by Private Electric Plants, by T. H. Amrine, published by the University of Illinois, Urbana, Ill., have been issued in a new edition in response to the demand. These are known as Bulletins Nos. 16 and 25, respectively.